PB-217 915

CHEMICAL WATER QUALITY ON THE LOWER KANSAS RIVER BASIN

Walter J. O'Brien, et al

Kansas University
Lawrence, Kansas

November 1966

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By

WALTER J. O'BRIEN

and

ERNEST E. ANGINO

Prepared Under Contract

PH 86-66-63

with the

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Federal Water Pollution Control Administration
General publications

K 13 Chemical water quality of lower Kansas River basin [with bibliography]; by Walter J. O'Brien and Ernest E. Angino. Nov. 1966. [Prepared in cooperation with University of Kansas, Center for Research, Inc., Engineering Science Division, Lawrence, Kans. under contract PH 86-66-63 Missouri-Souris-Red River Basins Comprehensive Water Pollution Control Project.]

(no LC number)

Chemical Water Quality on the Lower Kansas River Basin

by

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Prepared Under Contract
PH 86-66-63
with the
Federal Water Pollution Control Administration
Missouri-Souris-Red River Basins Comprehensive Water
Pollution Control Project

The University of Kansas
Center for Research, Inc.
Engineering Science Division
Lawrence, Kansas

November, 1966

I

Acknowledgement

The personnel of many agencies have contributed directly and indirectly to this study. However, special thanks are due Mr. Lewis A. Young, Project Director of the Missouri-Souris-Red River Basins Comprehensive Water Pollution Control Project, Federal Water Pollution Control Administration, and Mr. Melville W. Gray, Assistant Director of the Environmental Health Services Division, Kansas State Department of Health, for their enthusiastic cooperation and critical counsel.

The Environmental Health Services Division, Kansas State Department of Health, collected the water samples during the summer of 1966. The temperature and the specific conductance measurements tabulated in this report were also performed by this agency. The discharge values listed in the report were provided by the Kansas City District Office, U. S. Corps of Engineers, from gage height readings made by the Kansas State Department of Health at the time the samples were collected.

The chemical quality of the water samples collected during the summer of 1966 was analyzed by the Analytical Laboratory of the State Geological Survey of Kansas.

The water quality data used in developing the mathematical relationships for the sampling locations in existance prior to 1966 was obtained from the appropriate Water Supply Papers of the U. S. Geological Survey and the Bulletins of the Environmental Health Services Division, Kansas State Department of Health.

The mathematical analyses were performed on the facilities of the University of Kansas Computation Center. Mr. Donald Hey and Mr. Paul MacRoberts, graduate students at the University of Kansas, assisted with these computations.

Mrs. Mary K. Gratton and Mrs. Doris Harrison were responsible for typing the report manuscript.

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Figure 1.....Location Map of the Kansas River Basin Model Area

Figure 2.....Location Map of the Water Quality Sampling Stations

Introduction

On January 15, 1966, The University of Kansas Center for Research, Inc., entered into contract number PH 86-66-63 with the Division of Water Supply and Pollution Control, Federal Water Pollution Control Administration, for the development and evaluation of a mathematical model of the lower reaches of the Kansas River drainage basin. This model was to be used for operational and planning activities within the basin, and was to be capable of:

(1) Simulating the hydraulic behavior of the river system.

(2) Predicting the time history and distribution of a conservative or nonconservative pollutant throughout the river system.

(3) Predicting the location of critical areas of pollution under various river system developments.

During the course of this investigation, it became apparent that the biological, the chemical, and the time of flow data on the model region was insufficient to establish many of the parameters required to accurately describe the behavior of the drainage system. A field team from the Federal Water Pollution Control Administration was therefore authorized to conduct an intensive chemical quality, biological quality, and time of flow survey in the basin between March 23, 1966, and March 28, 1966. The Kansas State Department of Health assisted with this survey.

A modification to contract number PH 86-66-63 was adopted on June 28, 1966, to continue the field program started in the spring. This modification provided for the chemical analysis of twenty-two samples each week for a period of thirteen weeks and for the mathematical correlation of the data. The collection of the samples was to be carried out by the

Kansas State Department of Health under terms of a separate contract with the Federal Water Pollution Control Administration. The Kansas State Department of Health was also to measure a number of biological variables and to conduct time of flow studies under their contract.

This report summaraizes the activities conducted by the University of Kansas Center for Research, Inc., under the contract modification outlined above.

Model Region

The Kansas River Basin contains approximately 60,060 square miles and lies within the states of Colorado, Nebraska, and Kansas. Approximately eighty-five percent of the land area in the basin is semiarid. The eastern fifteen percent of the basin is humid.

The region of the basin included in the present study is shown by the hatched area in Figure 1. This area was isolated for study because it has sufficient water resources to support the continued development of an industrial economy and because the Kansas State Water Plan Studies (1)(2)(3)(4) provide an unusually comprehensive source of basic data on the region.

The study region is also bounded by six reservoirs as shown in Figure 2. The basin area below the reservoirs contains approximately 8,820 square miles. The average annual precipitation varies from 22 inches in the western portion of the region to 36 inches in the eastern portion near Kansas City. The geology is sedimentary in origin, and the eastern portion of the region shows the effects of recent glaciation. The valley floors of the major rivers are essentially flat

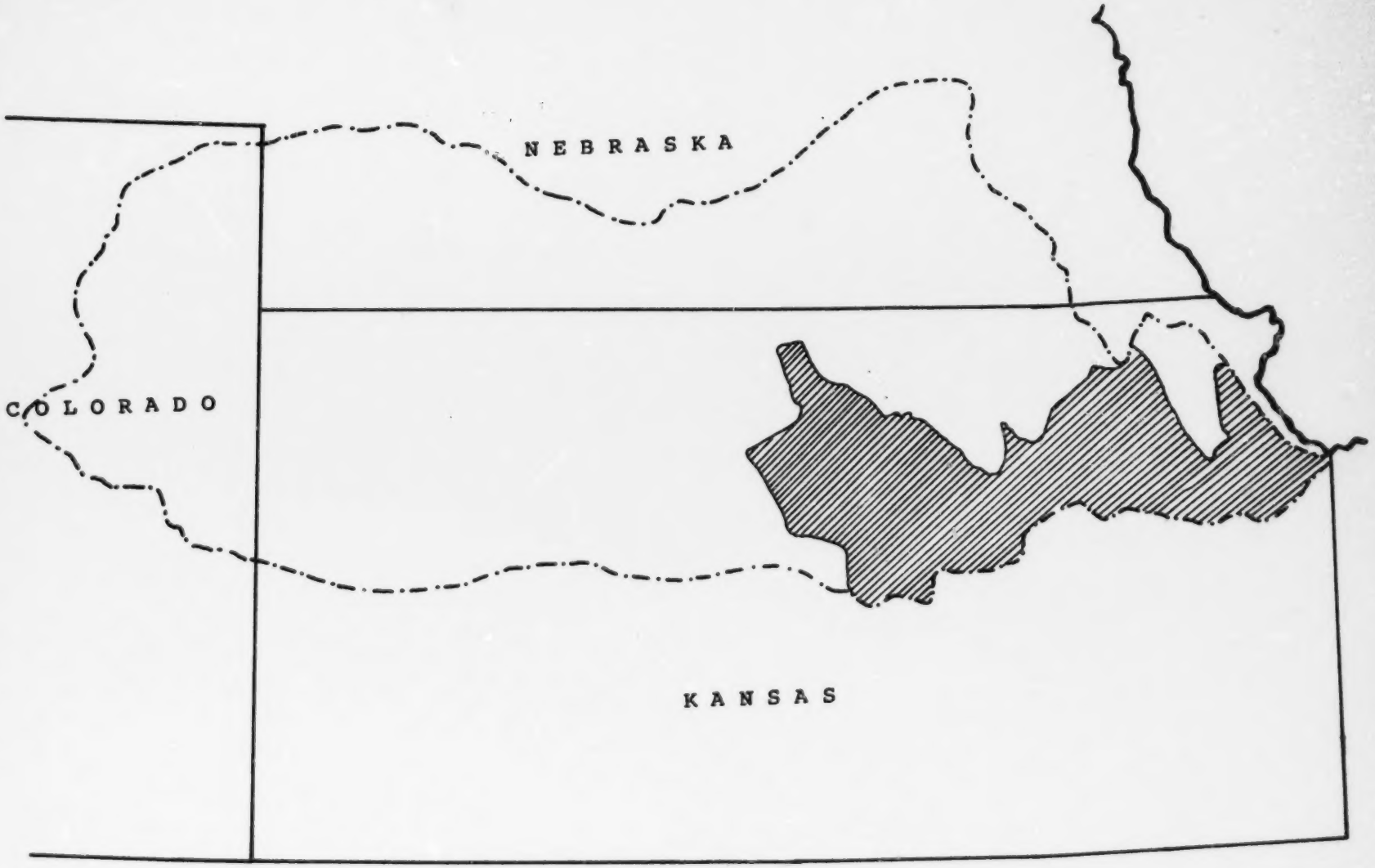

Figure 1 Location Map of the Kansas River Basin Model Area

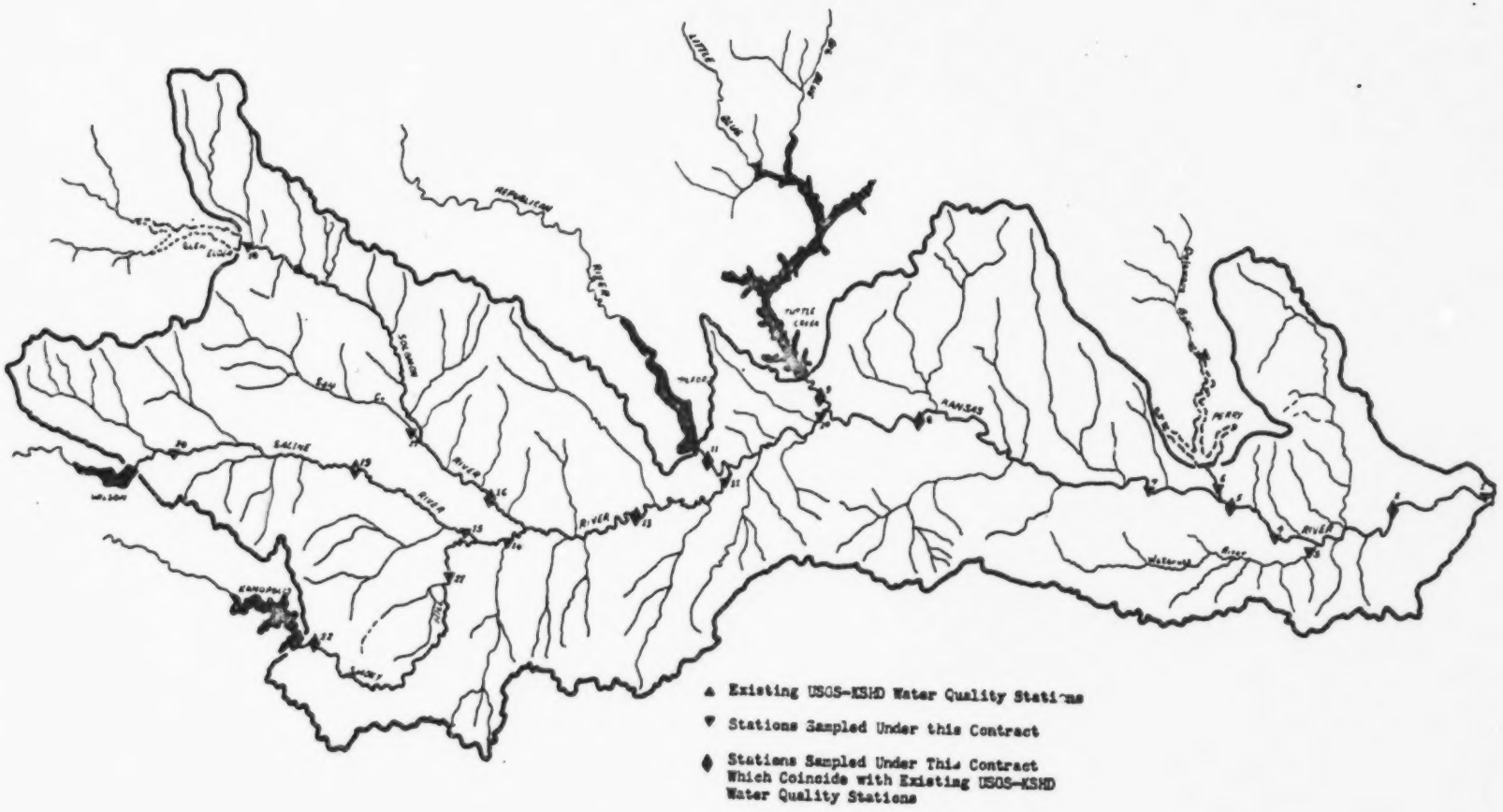
Existing USGS-KSHD Water Quality Stations
Stations Sampled Under this Contract
Stations Sampled Under This Contract Which Coincide with Existing USGS-KSHD Water Quality Stations

Figure 2 Location Map of the Water Quality Sampling Stations

and are filled with alluviam. The rivers have rapidly shifting beds and exhibit considerable meandering.

Sampling Sites

The location of the sampling sites used in the 1966 survey and the location of the currently active United States Geological Survey - Kansas State Health Department water quality stations are shown in Figure 2. These sites can be described as follows:

Station No.	River Mile	Description
1	0.3	Kansas River at James Street Bridge, Kansas City, Wyandotte County, Kansas.
2	20.3	Kansas River at state highway K7 bridge, 0.6 mile east of Bonner Springs, Wyandotte County. This station coincides with KSDH Station No. 20.3 and USGS Station No. 6-8925.
3	41.7-0.4	Wakarusa River at county road bridge on FAS 209, 0.5 mile north of Eudora, Douglas County.
4	53.1	Kansas River at U. S. 59 highway bridge, Lawrence, Douglas County.
5	64.1	Kansas River at county road bridge on FAS 330, 0.5 mile north of Lecompton, Douglas County. This station coincides with KSDH Station No. 64.7 and USGS Station No. 6-8910.
6	64.7-1.8	Deleware River at U. S. 24 highway bridge, 0.5 mile west of Perry,Jefferson County.
7	84.0	Kansas River at Sardou Bridge, Topeka, Shawnee County. This station coincides with USGS Gaging Station No. 6-8890.
8	129.1	Kansas River at State highway K99 bridge, Wamego, Pottawatomie County. This station coincides with KSDH Station No. 129.1 and USGS Station No. 6-8875.

9	147.1-7.3	Big Blue River at Casement Bridge on FAS 536, 2.4 miles below Tuttle Creek Dam, Riley County. This station coincides with USGS Gaging Station 6-8870. Water quality Stations KSDH 7.3 and USGS 6-8870 are collected at the outlet to Tuttle Creek Dam 2.4 miles upstream.
10	148.3	Kansas River at state highway K177 bridge, Manhattan, Riley County.
11	170.4-6.0	Republican River at U. S. 77 highway bridge, 2.0 miles below Milford Dam, Geary County. This site coincides with USGS Gaging Station No. 6-8571.
12	170.4-2.0	Smoky Hill River at U. S. 40 Alternate highway bridge, 1.5 miles east of Junction City, Geary County.
13	170.4-43.3	Smoky Hill River at state highway K43 bridge, Enterprise, Dickinson County. This station coincides with KSDH Station No. 55.4 and USGS Station No. 6-8776.
14	170.4-83.7	Smoky Hill River at county road bridge 1.0 mile west of FAS 595 and 2.0 miles east of New Cambria, Saline County. This station coincides with KSDH Station No. 55.4 and USGS Station No. 6-8776.
15	170.4-89.6-2.0	Saline River at county road bridge on FAS 1062, 0.5 mile south of New Cambria, Saline County. This station coincides with KSDH Station No. 2.5 or USGS Station No. 6-8701.
16	170.4-68.3-16.9	Solomon River at county road bridge on FAS 1050, 0.8 mile west of Niles, Ottawa County. This site coincides with KSDH Station No. 16.9 and USGS Station No. 6-8769.
17	170.4-68.3-45.9-10.4	Salt Creek at state highway K106 bridge, 1.5 miles south of Minneapolis, Ottawa County.

18	170.4-89.6-68.5	Saline River at county road bridge on FAS 466, Glen Elder, p.5 mile below Glen Elder Reservoir, Mitchell County.
19	170.4-89.6-68.5	Saline River at county road bridge on FAS 447, 0.5 mile south of Tescott, Ottawa County. This site coincides with KSDH Station No. 54.5 and USGS Station No. 6-8695.
20	170.4-89.6-113.5	Saline River at county road bridge on FAS 236, 0.5 mile south of Sylvan Grove, 8.0 miles below Wilson Dam, Lincoln County.
21	170.4-117.0	Smoky Hill River at Magnolia Road Bridge, 4.0 miles north of Mentor, Saline County. This site coincides with KSDH Station No. 131.5 and USGS Station No. 6-8665.
22	170.4-.77.0	Smoky Hill River at county road bridge, 0.5 mile downstream from Kanopolis Dam, 5 miles north of Langley, Ellsworth County. This site coincides with KSDH Station No. 207.3 and USGS Station No. 6-8655.

Published water quality data was also used in the mathematical analyses from the following stations.

Delaware River at Valley Falls, KSDH Station No. 30.6 and USGS Station No. 6-8905. Located 0.2 mile north of Valley Falls, Jefferson County, at mile 30.6

Republican River at Milford, KSDH Station No. 18.6 and USGS Station No. 6-8570. This station is located within the Milford Reservoir area and has been discontinued.

Solomon River at Beloit, KSDH Station No. 122.1 and USGS Station No. 6-8760. Located at bridge on state highway K14 in Beloit, Mitchell County.

Analytical Procedures

The samples were collected by the Kansas State Department of Health and arrived at the analytical laboratory of the State Geological

Survey of Kansas approximately 18 to 24 hours after collection. Separate samples were collected and refrigerated by the Kansas State Department of Health for the nitrate determinations. These were kept refrigerated until analyzed.

The samples were logged and the analyses initiated immediately after the samples reached the laboratory. The pH and nitrate analyses were completed first. Appropriate aliquots were then removed from each sample to measure the total solids concentration. Following this operation, the original one-liter samples were prefiltered and then filtered through 1.2-micron Millipore filters. The alkalinity was determined and the filtrate was then refrigerated until a portion was needed for the individual chemical analyses. The sequence of analysis was:

(1) Total Dissolved Solids
(2) Sodium and Potassium
(3) Phosphate
(4) Calcium and Magnesium
(5) Chloride and Sulfate
(6) Total Solids

This sequence was chosen with two objectives in mind:

(1) To assure the rapid analysis of the critical parameters (pH, alkalinity, and nitrate)

(2) To establish a routine for systematically processing each sample through a complete analysis.

The techniques used in the analyses were those recommended in the Twelfth Edition of Standard Methods for the Examination of Water and Wastewater unless otherwise noted. The details of the specific determinations were as follows:

The pH was determined by the glass electrode method using a Beckman zeromatic pH Meter. The measurements are expressed in pH units.

Alkalinity was determined by the potentiometric method using a pH of 4.8 for total alkalinity. The distribution of bicarbonate and carbonate alkalinity was calculated. The measurements are expressed in milligrams per liter as Calcium Carbonate.

Nitrate was determined by the ultraviolet spectrophotometric method. The measurements are expressed in milligrams per liter as nitrogen.

Total Dissolved Solids were determined by evaporating the filtered samples in a weighted dish on a steam bath and drying the residue to constant weight in a 180°C oven. The results are expressed in milligrams per liter.

Sodium and Potassium were determined by the flame photometric method. Both of the analyses are expressed in milligrams per liter as the ion.

Phosphate was determined as orthophosphate by the stannous chloride method. The measurements are expressed in milligrams per liter as phosphate.

Calcium and Magnesium were determined using a Jarrell-Ash Model 82-516 Atomic Absorption Spectrophotometer using Westinghouse hollow-cathode tubes. Extensive testing of this technique has demonstrated these elements can be measured accurately at the 0.05 milligram per liter level with a coefficient of variation of less than three percent. The measurements are expressed in milligrams per liter as the ion.

Chloride was determined by the argentometric method. The measurements are expressed in milligrams per liter as the ion.

Sulfate was determined by the gravimetric method with ignition of residue. The measurements are expressed in milligrams per liter as sulfate.

Total Solids were determined by evaporating the unfiltered samples in a weighted dish on a steam bath and drying the residue to constant weight in a 180°C oven. The results are expressed in milligrams per liter.

The following parameters are also tabulated with the data:

The temperature was determined by the Kansas State Department of Health with immersion thermometers in the field at the time of collection. The measurements are expressed in degrees Centigrade.

The specific conductance was determined by the Kansas State Department of Health either in the field or in the laboratory. The measurements are expressed in micromhos per centimeter at twenty-five degrees Centigrade.

The discharge was supplied by the Kansas City District Office, U. S. Corps of Engineers, from gage height readings made by the Kansas State Department of Health at the time the samples were collected. These measurements are expressed in cubic feet per second.

Station 1 Kansas River at Kansas City

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		7.75	20°C	320	12.6	3.7	42.0	4.8
6/20/66		8.15	26°C	650	53.4	4.6	87.0	16.0
6/27/66		8.35	26°C	790	62.0	11.0	88.0	18.5
7/04/66		7.27	30°C	680	62.0	11.3	61.0	14.0
7/11/66		7.66	30°C	530	40.1	8.3	56.9	10.0
7/18/66		7.64	29°C	685	58.0	12.5	67.2	15.0
7/25/66		8.30	28°C	790	70.0	13.2	81.2	17.0
8/01/66		7.80	27°C	840	70.8	13.3	68.8	17.0
8/08/66		7.58	27°C	750	74.0	13.1	75.0	12.5
8/15/66		7.73	25°C	690	55.0	11.0	73.0	13.0
8/22/66		7.63	25°C	520	39.0	8.5	51.4	7.4
8/29/66		7.45	25°C	370	28.0	8.2	42.5	5.9

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	21.0	00.0	112.6	32.5	4.2	0.19	228	2654
6/20/66	52.1	13.6	164.4	68.7	4.5	0.77	482	920
6/27/66	81.6	20.8	136.2	82.7	1.3	0.34	548	728
7/04/66	67.2	00.0	119.6	93.0	1.7	0.50	522	528
7/11/66	48.2	00.0	114.4	72.0	3.7	0.61	402	520
7/18/66	59.8	00.0	153.8	87.3	2.6	0.81	500	570
7/25/66	76.8	18.8	159.2	104.5	2.1	0.93	580	624
8/01/66	110.8	3.6	140.6	86.0	2.5	0.93	584	756
8/08/66	83.4	00.0	162.8	85.2	4.4	0.94	504	564
8/15/66	66.2	00.0	162.8	80.7	5.2	1.00	504	576
8/22/66	45.8	00.0	125.0	64.2	4.1	9.2	406	494
8/29/66	29.2	00.0	101.0	42.4	5.5	0.58	312	938

Remarks:

Station .2 Kansas River at Bonner Springs

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	36,000 cfs	7.80	22°C	400	17.8	4.1	44.0	7.0
6/20/66	2,600 cfs	8.63	26°C	600	51.9	4.2	75.0	13.0
6/27/66	17,000 cfs	7.40	25°C	340	18.0	5.6	41.0	8.0
7/04/66	2,100 cfs	8.53	30°C	820	72.3	12.3	86.0	16.5
7/11/66	2,600 cfs	7.96	29°C	570	46.0	9.3	60.4	11.0
7/18/66	2,100 cfs	8.51	29°C	580	51.0	12.9	63.0	15.5
7/25/66	2,300 cfs	8.03	28°C	600	50.0	11.5	66.2	13.0
8/01/66	2,100 cfs	7.62	28°C	1040	95.0	14.0	48.2	14.0
8/08/66	1,800 cfs	8.38	25°C	660	64.0	13.2	68.8	10.8
8/15/66	1,800 cfs	8.47	25°C	740	62.0	11.6	73.5	13.5
8/22/66	2,000 cfs	8.24	25°C	600	47.0	10.3	59.0	10.4
8/29/66	3,400 cfs	7.76	25°C	360	24.3	8.5	47.5	6.1
9/12/66		7.95	24°C	460			58.8	8.0
9/19/66		8.30	18°C	560			90.0	11.2
10/03/66		8.64					67.5	11.8
10/31/66							71.8	15.3

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	27.1	0.0	123.0	38.3	4.9	0.19	518	7600
6/20/66	58.3	30.8	144.2	73.3	1.9	0.17	448	920
6/27/66	20.4	0.0	107.8	28.4	3.4	0.22	246	3542
7/04/66	81.6	26.0	141.2	115.2	1.5	0.84	610	710
7/11/66	50.1	6.0	126.0	54.3	3.8	0.48	426	656
7/18/66	53.6	20.4	123.0	79.0	2.6	0.41	464	538
7/25/66	54.4	8.8	135.2	65.0	3.1	0.33	446	1254
8/01/66	181.8	0.0	107.2	100.8	2.2	0.17	670	754
8/08/66	70.8	17.2	133.8	79.0	5.4	0.56	474	612
8/15/66	76.8	22.8	141.4	88.9	3.5	0.73	526	654
8/22/66	53.0	12.4	138.6	35.4	4.4	12.50	458	708
8/29/66	25.0	0.0	120.0	44.0	5.7	0.38	264	1888
9/12/66	41.2	6.0	112.0	61.7	6.1	0.60	414	858
9/19/66	41.6	16.0	136.2	57.1	6.3	.46	408	748
10/03/66	50.6	28.8	142.6	42.4	3.2	.35	448	686

Remarks:

Station 3 Wakarusa River at Eudora

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		7.85	20°C	170	4.3	1.6	27.0	3.3
6/20/66		8.10	26°C	410	16.3	2.2	90.0	11.5
6/27/66		7.40	23°C	230	5.3	4.3	37.0	5.0
7/04/66		7.86	30°C	450	10.2	5.8	78.3	10.5
7/11/66		7.53	30°C	325	7.6	4.4	54.3	7.5
7/18/66		8.22	30°C	375	8.7	55.1	57.0	9.5
7/25/66		7.64	28°C	395	10.5	5.8	68.8	10.5
8/01/66		7.62	27°C	490	11.0	4.9	81.0	12.0
8/08/66		7.72	27°C	480	18.5	5.4	80.0	11.0
8/15/66		7.76	25°C	470	16.8	4.0	71.3	11.8
8/22/66		7.43	24°C	270	6.5	4.8	42.8	5.2
8/29/66		7.67	25°C	310	8.3	4.1	57.5	6.9
10/31/66							63.7	12.0

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	1.0	0.0	88.4	18.9	5.4	0.17	140	9914
6/20/66	9.5	10.4	190.2	49.8	4.1	0.15	324	456
6/27/66	3.7	0.0	79.2	12.8	3.7	0.06	160	2406
7/04/66	7.2	4.4	170.8	32.5	2.4	0.00	298	496
7/11/66	6.1	0.0	115.2	34.2	3.3	0.17	226	382
7/18/66	6.8	11.2	113.6	32.5	2.9	0.13	230	292
7/25/66	9.6	0.0	147.0	37.5	1.8	0.11	248	294
8/01/66	11.6	0.0	193.6	22.2	1.6	0.00	304	326
8/08/66	16.4	0.0	201.2	35.4	1.8	0.06	312	418
8/15/66	15.8	0.0	191.2	28.8	1.6	0.07	294	316
8/22/66	5.4	0.0	108.0	21.4	3.6	0.60	194	490
8/29/66	7.4	0.0	126.8	Trace	2.4	0.06	214	288
10/31/66								

Remarks:

Station 4 Kansas River at Lawrence

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		7.80	20°C	160	3.9	2.7	27.0	3.3
6/20/66		8.73	27°C	725	60.8	5.6	87.0	15.0
6/27/66		7.33	24°C	250	10.8	5.0	34.0	5.0
7/04/66		7.98	31°C	770	69.0	13.3	74.0	13.0
7/11/66		7.76	30°C	700	52.5	10.3	65.0	13.0
7/18/66		8.43	32°C	600	46.5	13.0	57.6	15.5
7/25/66		8.29	31°C	700	56.0	13.2	72.5	14.0
8/01/66		8.10	29°C	900	90.1	13.3	70.5	15.0
8/08/66		7.91	27°C	690	63.7	14.2	75.0	11.8
8/15/66		8.57	28°C	750	62.0	11.8	71.5	13.8
8/22/66		8.40	24°C	600	50.0	10.3	54.4	10.6
8/29/66		7.70	26°C	370	27.0	8.5	45.0	6.1
9/12/66		7.95	24°C	510			58.8	8.5
9/19/66		8.10	19°C	560			89.5	11.8
10/3/66		8.60					67.5	12.2

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	0.0	0.0	101.6	Trace	2.7	0.33	158	6142
6/20/66	72.3	28.0	148.2	83.1	1.9	0.30	492	980
6/27/66	11.2	0.0	74.2	17.7	3.5	0.15	182	3900
7/04/66	74.0	6.4	147.8	97.1	1.2	0.15	548	726
7/11/66	58.4	0.0	140.4	57.6	1.7	0.50	456	640
7/18/66	47.0	15.6	120.6	60.1	1.9	0.30	442	548
7/25/66	70.4	14.4	140.6	76.1	1.6	0.22	506	586
8/01/66	117.6	7.2	133.8	101.2	3.1	0.31	552	756
8/08/66	72.8	4.4	148.6	94.7	4.4	0.64	470	644
8/15/66	81.4	21.6	138.0	88.5	1.6	0.48	508	628
8/22/66	56.8	17.2	135.4	70.8	1.6	0.40	474	632
8/29/66	28.8	0.0	100.6	42.0	4.2	0.42	272	782
9/12/66	47.6	6.0	112.0	58.9	5.4	0.55	448	784
9/19/66	42.6	9.6	144.4	53.5	4.0	0.48	412	622
10/3/66	47.8	25.2	146.2	46.9	2.4	0.17	446	692

Remarks:

Station 5 Kansas River at Lecompton

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	35,000 cfs	7.70	20°C	150	3.0	2.1	22.5	3.1
6/20/66	1,700 cfs	8.02	27°C	590	30.4	2.7	100.2	16.0
6/27/66	13,000 cfs	7.30	24°C	210	6.6	3.9	30.0	5.5
7/04/66	1,700 cfs	8.23	31°C	650	54.7	12.0	63.0	14.0
7/11/66	1,900 cfs	7.94	31°C	520	41.6	9.5	63.5	12.0
7/18/66	1,300 cfs	8.10	32°C	615	43.5	11.1	66.0	16.0
7/25/66	1,750 cfs	8.25	30°C	680	57.0	12.5	66.2	13.5
8/01/66	1,650 cfs	7.89	27°C	660	44.0	8.3	70.5	11.5
8/08/66	1,800 cfs	8.06	27°C	690	59.0	13.1	75.0	11.8
8/15/66	1,800 cfs	8.40	28°C	670	52.0	10.4	68.8	13.8
8/22/66	3,300 cfs	7.82	24°C	380	10.4	6.3	60.0	8.8
8/29/66	2,900 cfs	7.70	26°C	390	25.0	9.0	47.5	6.9
10/31/66							71.7	16.7

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	0.0	0.0	88.0	Trace	3.8	0.23	120	7656
6/20/66	27.9	12.0	226.0	56.4	3.7	0.30	402	622
6/27/66	1.7	0.0	73.8	7.4	4.9	0.30	168	4786
7/04/66	56.4	12.0	138.6	73.3	1.3	0.00	482	902
7/11/66	43.6	4.0	135.8	62.6	2.2	0.32	414	608
7/18/66	39.2	8.8	149.8	74.9	1.7	0.28	442	554
7/25/66	74.4	10.4	136.4	72.9	1.6	0.13	496	850
8/01/66	50.2	4.8	165.6	64.6	3.1	0.28	404	648
8/08/66	77.2	7.2	154.8	85.2	3.5	0.52	462	878
8/15/66	63.8	16.4	145.8	75.3	1.5	0.39	472	722
8/22/66	13.6	0.8	151.2	26.0	3.0	0.40	274	454
8/29/66	29.8	0.0	121.6	37.0	4.2	0.42	294	1434
10/31/66								

Remarks:

Station 6 Delaware River at Perry

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		7.60	21°C	150	2.9	2.1	23.5	3.5
6/20/66		8.05	25°C	480	17.1	1.9	107.5	16.0
6/27/66		7.25	23°C	220	5.8	4.3	32.0	6.0
7/04/66		8.17	31°C	550	14.6	5.9	91.0	15.0
7/11/66		7.66	31°C	400	11.0	5.0	62.0	9.0
7/18/66		8.10	32°C	580	18.3	7.2	95.0	16.5
7/25/66		7.89	31°C	390	12.3	4.8	63.8	8.0
8/01/66		7.91	28°C	520	18.1	4.7	76.0	13.5
8/08/66		8.21	27°C	490	16.5	5.0	82.5	13.0
8/15/66		8.02	26°C	450	17.2	4.0	58.8	12.5
8/22/66		7.80	23°C	400	16.2	5.8	59.0	9.0
8/29/66		8.18	29°C	370	12.0	5.8	57.5	9.5
10/31/66							108.0	20.0

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	0.0	0.0	86.8	4.5	3.2	0.46	148	3604
6/20/66	11.7	14.0	242.4	43.7	4.2	0.37	374	588
6/27/66	3.1	0.0	73.8	10.7	4.2	0.14	176	4156
7/04/66	9.0	15.6	199.6	45.3	1.1	0.00	364	386
7/11/66	7.9	0.0	140.4	32.9	3.5	0.30	248	350
7/18/66	12.0	11.6	208.8	44.0	1.7	0.30	338	382
7/25/66	10.8	3.6	136.6	26.3	2.4	0.16	310	396
8/01/66	16.6	4.8	181.4	38.7	2.2	0.15	322	408
8/08/66	13.8	16.0	184.0	46.1	1.4	0.21	332	388
8/15/66	9.0	11.6	166.4	32.9	1.5	0.13	300	374
8/22/66	13.6	2.0	156.2	29.8	2.8	0.40	284	564
8/29/66	12.8	8.8	123.2	26.8	2.5	0.00	236	286
10/31/66								

Remarks:

Station 7 Kansas River at Topeka

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	1,500 cfs	7.65	22°C	540	57.1	5.6	45.5	10.0
6/20/66	2,900 cfs	8.43	29°C	850	117.5	10.0	77.0	17.0
6/27/66	1,300 cfs	8.31	26°C	790	60.0	12.0	78.0	18.0
7/04/66	1,500 cfs	8.20	31°C	660	63.3	15.0	50.6	14.0
7/11/66	1,400 cfs	8.12	31°C	660	54.5	13.0	57.5	14.0
7/18/66	800 cfs	8.09	33°C	650	51.5	14.3	61.8	18.0
7/25/66	1,450 cfs	8.20	30°C	680	61.0	13.2	59.5	14.0
8/01/66	1,150 cfs	8.13	27°C	640	44.1	12.0	62.2	12.0
8/08/66	1,700 cfs	8.30	27°C	690	59.2	13.8	75.0	12.5
8/15/66	1,700 cfs	8.47	28°C	690	54.0	12.5	68.8	14.3
8/22/66	3,000 cfs	7.89	24°C	520	41.0	9.0	49.0	9.2
8/29/66	2,600 cfs	7.88	27°C	420	27.8	10.5	37.5	7.0
9/12/66		8.10	22°C	650			61.2	9.0
9/19/66		8.31	18°C	570			90.0	12.2
10/03/66		8.71					70.0	13.2
10/31/66							71.7	16.5

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	57.9	0.0	139.4	52.7	2.8	0.29	420	2220
6/20/66	143.3	22.4	135.4	109.9	1.8	0.17	670	1206
6/27/66	93.3	18.0	131.2	100.4	1.3	0.00	550	808
7/04/66	73.6	8.0	113.0	145.0	1.7	0.22	490	600
7/11/66	62.7	8.4	139.2	79.0	1.5	0.37	474	808
7/18/66	64.0	7.6	142.4	69.6	1.5	0.18	482	596
7/25/66	80.6	12.0	126.0	70.4	1.3	0.06	486	618
8/01/66	62.8	10.0	140.0	61.3	3.2	0.44	392	818
8/08/66	77.6	16.0	149.4	79.9	3.2	0.51	454	892
8/15/66	80.2	20.0	148.4	68.7	1.8	0.26	502	764
8/22/66	51.0	1.6	140.0	57.6	3.3	0.40	382	1340
8/29/66	39.2	2.0	122.8	43.6	4.1	0.36	288	1462
9/12/66	58.4	10.0	122.0	66.7	4.7	0.58	534	1022
9/19/66	43.1	13.6	148.2	53.9	4.3	0.32	418	782
10/03/66	52.1	26.4	152.8	45.7	2.3	0.17	434	692

Remarks:

Station 8 Kansas River at Wamego

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	1,500 cfs	8.45	23°C	2000	274.5	14.4	110.0	29.6
6/20/66	2,400 cfs	8.20	27°C	1100	145.0	10.0	98.0	18.5
6/27/66	1,400 cfs	8.46	27°C	900	68.0	12.5	87.0	18.0
7/04/66	1,500 cfs	8.55	30°C	780	79.0	14.3	54.2	14.0
7/11/66	1,500 cfs	8.45	30°C	650	50.0	13.5	68.4	13.5
7/18/66	1,100 cfs	7.98	26°C	800	69.0	17.0	76.0	18.0
7/25/66	1,500 cfs	7.90	26°C	680	57.0	13.2	70.0	17.0
8/01/66	1,200 cfs	7.93	26°C	580	36.5	12.0	55.2	12.0
8/08/66	1,800 cfs	7.99	27°C	590	46.0	12.5	67.5	17.5
8/15/66	1,200 cfs	8.40	30°C	770	64.0	12.2	73.0	14.5
8/22/66	2,500 cfs	8.10	24°C	620	54.5	10.5	59.0	10.2
8/29/66	2,100 cfs	7.55	27°C	450	27.8	12.8	57.3	7.8
9/02/66		8.10	23°C	540			61.2	10.1
9/19/66		8.17	19°C	560			90.0	13.0
10/03/66		8.43					67.5	12.8
10/31/66							51.7	13.4

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	318.5	00.0	221.2	189.4	2.0	0.08	1290	1656
6/20/66	177.4	15.2	175.0	130.1	2.4	0.30	762	1206
6/27/66	99.5	24.0	136.0	105.4	1.2	0.07	582	850
7/04/66	103.2	18.0	111.0	63.4	1.3	0.00	532	708
7/11/66	55.8	18.4	143.4	78.2	1.4	0.37	464	618
7/18/66	87.6	5.6	170.4	80.3	2.0	0.45	550	636
7/25/66	75.6	4.8	154.2	74.1	1.8	0.27	486	674
8/01/66	52.2	4.4	125.8	59.3	3.5	0.62	454	794
8/08/66	60.0	8.0	151.0	68.7	4.0	0.32	424	818
8/15/66	92.2	19.6	146.0	88.5	2.2	0.31	536	752
8/22/66	69.4	4.4	142.4	66.7	2.1	0.40	430	804
8/29/66	30.8	00.0	177.2	40.7	5.1	0.38	292	2496
9/02/66	43.2	8.0	134.0	55.2	4.2	0.45	416	1094
9/19/66	39.2	12.0	147.8	48.6	3.4	0.30	402	586
10/03/66	66.0	18.4	154.6	45.3	2.8	0.20	446	616

Remarks:

Station 9 Blue River below Tuttle Creek Dam

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	150 cfs	8.45	22°C	450	19.5	6.5	58.0	12.8
6/20/66	1,000 cfs	7.91	22°C	360	24.8	13.7	62.0	12.0
6/27/66	200 cfs	8.03	23°C	440	20.0	9.5	63.0	14.0
7/04/66	800 cfs	7.88	25°C	440	20.4	11.3	57.3	12.0
7/11/66	800 cfs	7.68	28°C	420	20.5	9.5	57.5	11.0
7/18/66	200 cfs	7.71	24°C	460	20.4	10.3	61.8	15.0
7/25/66	900 cfs	7.61	24°C	450	23.5	9.7	61.2	14.5
8/01/66	25 cfs	7.64	27°C	470	15.8	14.3	57.5	13.5
8/08/66	300 cfs	7.90	25°C	450	24.0	9.8	60.0	11.0
8/15/66	100 cfs	7.99	27°C	470	23.0	8.4	58.8	13.3
8/22/66	800 cfs	7.73	23°C	450	25.0	9.8	52.6	10.8
8/29/66	12 cfs	7.80	26°C	520	24.5	8.8	75.0	14.8
9/12/66		8.05	23°C	430			56.2	12.1
9/19/66		8.03	21°C	430			80.2	12.5
10/03/66		7.96					58.8	10.9
10/31/66							36.2	11.0

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	15.5	00.0	185.0	27.2	2.0	0.00	344	402
6/20/66	18.2	6.4	141.6	46.1	3.1	0.24	338	394
6/27/66	17.5	6.4	139.0	46.5	3.7	0.17	344	422
7/04/66	17.6	4.0	139.8	27.2	2.6	0.00	372	440
7/11/66	18.9	00.0	140.2	50.6	3.0	0.13	358	434
7/18/66	18.6	00.0	148.4	37.0	2.7	0.05	342	420
7/25/66	20.0	00.0	146.0	46.9	2.4	0.13	340	438
8/01/66	21.8	00.0	151.8	40.7	2.0	0.06	294	394
8/08/66	17.4	4.8	154.8	49.0	2.7	0.00	342	474
8/15/66	21.0	6.0	159.2	34.2	2.9	0.01	368	430
8/22/66	18.0	00.0	157.2	47.3	3.6	0.00	374	496
8/29/66	21.4	1.6	196.4	33.8	2.2	0.20	346	392
9/12/66	17.2	10.0	140.0	37.0	3.3	0.15	370	472
9/19/66	16.7	7.2	141.1	37.4	3.2	0.10	342	404
10/03/66	22.1	6.8	156.2	32.9	4.2	0.20	374	422

Remarks:

Station 10 Kansas River at Manhattan

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micrombos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		8.40	24°C	1000	96.4		10.8	77.0
6/20/66		8.08	26°C	1200	155.0		11.8	100.0
6/27/66		8.43	27°C	1100	91.0		15.0	110.0
7/04/66		8.62	33°C	1200	142.2		19.0	86.0
7/11/66		8.36	32°C	800	79.0		17.5	79.0
7/18/66		8.08	27°C	950	87.0		19.5	78.8
7/25/66		8.13	26°C	1000	98.8		19.0	77.5
8/01/66		7.73	27°C	650	45.0		13.0	53.2
8/08/66		7.98	26°C	730	67.0		14.8	75.0
8/15/66		8.27	29°C	760	61.0		12.3	73.0
8/22/66		8.02	22°C	890	93.1		13.3	76.2
8/29/66		7.76	26°C	480	34.0		11.8	57.5
9/12/66		8.10	24°C	550				70.0
9/19/66		8.20	18°C	850				104.2
10/03/66		8.49						100.0

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	139.1	00.0	179.0	117.3	3.4	0.15	630	1250
6/20/66	189.3	12.0	166.2	152.3	3.7	0.46	722	2004
6/27/66	157.6	22.4	172.2	146.5	1.4	0.28	716	976
7/04/66	190.8	30.4	133.6	111.5	2.0	0.22	724	902
7/11/66	96.1	23.2	156.4	100.4	1.5	0.59	528	678
7/18/66	123.2	9.2	172.4	95.9	1.9	0.51	594	720
7/25/66	142.6	13.2	166.6	99.6	1.6	0.35	630	760
8/01/66	75.0	00.0	119.6	68.3	3.9	0.42	466	870
8/08/66	97.4	7.2	153.0	91.4	3.9	0.24	474	1026
8/15/66	83.4	13.6	157.2	87.3	2.9	0.27	502	770
8/22/66	123.4	5.2	159.4	100.0	2.6	0.40	566	750
8/29/66	38.8	00.0	169.6	45.7	4.4	0.36	310	2250
9/12/66	62.2	10.0	136.0	62.2	4.2	0.60	470	1450
9/19/66	105.4	12.4	169.6	82.3	2.8	0.40	516	1212
10/03/66	159.4	27.2	190.4	79.4	1.9	0.28	754	940

Remarks:

Station 11 Republican River below Milford Dam

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	225 cfs	8.30	25°C	800	68.3	14.5	59.0	13.6
6/20/66	300 cfs	8.16	22°C	700	56.4	6.9	85.0	15.5
6/27/66	250 cfs	8.08	24°C	900	53.0	18.2	110.0	22.5
7/04/66	375 cfs	7.99	30°C	440	22.5	17.5	57.3	11.0
7/11/66	400 cfs	8.19	31°C	520	29.3	18.7	56.8	11.0
7/18/66	350 cfs	7.87	28°C	560	31.3	17.8	66.4	17.0
7/25/66	600 cfs	8.20	28°C	560	37.5	17.7	72.5	15.5
8/01/66	1,000 cfs	7.80	29°C	490	23.8	15.5	48.8	10.5
8/08/66	500 cfs	7.89	27°C	520	32.6	16.9	67.5	12.3
8/15/66	400 cfs	8.01	25°C	570	35.0	14.5	63.5	13.8
8/22/66	700 cfs	7.79	22°C	450	30.1	11.5	47.0	10.2
8/29/66	720 cfs	7.69	24°C	470	29.5	14.5	61.2	10.4
9/12/66		8.15	23°C	460			70.0	10.2
9/19/66		8.15	19°C	400			75.0	9.0
10/03/66		8.18					88.8	16.5
10/31/66							71.7	18.0

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	102.1	00.0	158.2	77.0	4.8	0.37	490	1042
6/20/66	66.8	18.0	175.8	91.8	1.7	0.40	462	650
6/27/66	65.2	14.0	216.2	116.5	1.4	0.69	568	718
7/04/66	15.6	4.8	136.4	39.9	4.6	0.59	296	524
7/11/66	17.0	12.0	162.0	67.9	1.8	0.60	342	488
7/18/66	21.2	4.0	172.2	66.7	1.9	0.35	376	524
7/25/66	31.8	12.4	154.8	69.6	1.8	0.35	372	520
8/01/66	22.4	0.8	143.6	37.9	4.6	0.45	382	502
8/08/66	25.6	5.2	180.2	64.2	2.3	0.00	360	368
8/15/66	28.4	8.0	178.0	58.9	2.3	0.40	358	568
8/22/66	25.4	1.6	141.2	56.0	2.7	0.30	310	666
8/29/66	25.6	00.0	142.4	55.2	4.9	0.45	316	682
9/12/66	17.6	12.0	145.0	45.7	2.0	0.10	402	694
9/19/66	13.7	11.6	124.2	36.2	3.0	0.36	290	732
10/03/66	35.0	16.8	218.8	57.2	2.1	0.39	490	1044

Remarks:

Station 12 Smoky Hill River at Junction City

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		8.10	24°C	950	74.2	8.7	82.0	18.8
6/20/66		8.04	22°C	1200	155.0	11.4	100.0	17.5
6/27/66		8.10	24°C	1300	140.0	14.0	110.0	21.0
7/04/66		8.21	29°C	1950	251.0	21.5	101.2	27.0
7/11/66		8.00	32°C	1800	210.0	17.5	99.0	24.5
7/18/66		7.76	30°C	2500	287.5	18.3	120.0	35.0
7/25/66		7.70	28°C	3000	387.5	17.2	125.0	37.0
8/01/66		7.65	28°C	1180	95.0	13.8	68.8	13.0
8/08/66		7.63	27°C	780	73.5	12.4	73.8	9.8
8/15/66		7.72	25°C	870	75.0	11.0	77.5	13.3
8/22/66		8.10	23°C	1290	145.0	13.7	48.4	14.8
8/29/66		7.53	23°C	420	29.4	10.5	55.0	6.2

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	119.5	00.0	176.0	117.3	4.9	0.19	600	1352
6/20/66	194.8	10.0	141.0	164.6	2.9	0.32	756	1642
6/27/66	194.7	8.4	148.8	163.0	2.8	0.19	786	1048
7/04/66	355.6	16.8	184.2	219.0	1.8	0.00	1200	1290
7/11/66	358.8	7.2	151.0	185.2	1.4	0.10	1078	1178
7/18/66	538.2	00.0	184.0	216.5	1.8	0.04	1464	1534
7/25/66	627.0	00.0	198.4	230.1	1.4	0.08	1734	1776
8/01/66	208.0	00.0	136.2	102.5	3.7	0.39	682	1440
8/08/66	116.8	00.0	137.8	97.5	4.5	0.26	500	1414
8/15/66	120.0	00.0	158.2	108.3	3.6	0.19	574	1048
8/22/66	228.6	9.6	171.0	131.3	3.6	0.40	800	1076
8/29/66	35.0	00.0	207.8	48.6	5.5	0.33	294	4130

Remarks:

Station 13 Smoky Hill 2 at Enterprise

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	550 cfs	7.90	26°C	1100	335.8	10.4	79.0	17.4
6/20/66	800 cfs	7.90	23°C	1100	140.0	10.5	99.0	15.0
6/27/66	155 cfs	8.33	27°C	1800	235.0	17.0	116.0	21.5
7/04/66	150 cfs	8.30	29°C	1880	251.0	22.5	100.5	22.0
7/11/66	75 cfs	8.45	32°C	3000	445.0	22.0	101.8	25.5
7/18/66	65 cfs	7.88	32°C	4000	587.5	25.8	154.6	37.5
7/25/66	500 cfs	7.85	28°C	5000	69.5	26.0	157.5	42.0
8/01/66	700 cfs	7.53	30°C	900	65.0	13.3	43.8	9.5
8/08/66	700 cfs	7.61	26°C	930	97.0	14.0	80.0	11.8
8/15/66	400 cfs	7.50	24°C	910	97.0	10.5	64.0	10.8
8/22/66	4500 cfs	7.57	22°C	320	22.5	6.2	20.0	4.8
8/29/66	1400 cfs	7.55	23°C	580	49.5	11.5	63.8	7.6
9/12/66								
9/19/66								
10/03/66								
10/31/66							120.0	24.7

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	189.5	0.0	171.6	127.6	4.0	0.23	726	1010
6/20/66	177.8	6.0	134.0	153.1	3.5	0.30	734	1254
6/27/66	348.3	15.6	144.8	195.1	2.5	0.35	1098	1238
7/04/66	349.0	16.0	144.0	210.7	2.2	0.17	1182	1194
7/11/66	714.9	19.6	128.2	231.7	1.6	0.07	1790	1870
7/18/66	1074.2	3.2	175.4	294.7	1.8	0.22	2526	2596
7/25/66	1237.4	8.0	202.0	330.5	1.6	0.34	2944	3000
8/01/66	147.6	0.0	122.8	68.7	4.6	0.46	570	1976
8/08/66	149.2	0.0	142.2	117.3	4.0	0.28	598	1142
8/15/66	152.0	0.0	115.8	89.7	3.5	0.54	646	936
8/22/66	32.6	0.0	130.6	31.7	3.4	0.20	300	5972
8/29/66	71.2	0.0	152.4	72.0	4.7	0.24	438	2008
9/12/66								
9/19/66								
10/03/66								
10/31/66								

Remarks: SH-13

The measured chloride concentration for the July 25, 1966 sample is significantly greater than the expected value. It is not possible to obtain a balance between the measured anions and cations in the sample. Contamination of the sample container with hydrochloric acid is the suspected cause of the error. This analysis should not be used in any subsequent mathematical analyses.

Station 14 Smoky Hill River at New Cambria

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	250 cfs	8.00	27°C	950	126.1	12.3	82.0	20.4
6/20/66	675 cfs	7.38	27°C	1000	122.5	9.9	94.0	13.0
6/27/66	160 cfs	7.90	25°C	1075	122.5	14.3	96.0	17.0
7/04/66	155 cfs	8.71	31°C	1100	122.5	18.0	93.2	16.5
7/11/66	130 cfs	8.86	31°C	1400	147.5	11.8	100.7	21.0
7/18/66	125 cfs	8.20	28°C	1750	185.0	22.0	104.0	26.0
7/25/66	110 cfs	7.61	28°C	700	73.0	14.5	68.8	13.0
8/01/66	700 cfs	7.60	29°C	920	80.0	13.8	75.0	11.5
8/08/66	600 cfs	7.80	26°C	790	70.0	12.8	73.8	9.8
8/15/66	300 cfs	7.73	26°C	1100	131.3	13.8	76.3	13.5
8/22/66	2,500 cfs	7.62	22°C	260	10.5	7.5	25.8	2.4
8/29/66	450 cfs	7.70	25°C	940	92.5	12.8	75.0	10.2

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	289.5	00.0	164.0	125.9	3.5	0.40	694	1192
6/20/66	158.3	00.0	129.0	107.0	3.2	0.04	660	1234
6/27/66	164.7	4.0	128.6	131.3	2.9	0.59	682	858
7/04/66	164.8	32.8	119.8	124.7	3.7	0.91	752	796
7/11/66	258.9	40.0	113.8	174.5	1.7	0.87	952	1008
7/18/66	333.2	16.4	168.0	181.9	5.4	2.28	1154	1234
7/25/66	97.8	00.0	132.0	87.7	4.0	0.97	514	986
8/01/66	137.2	00.0	161.2	105.0	3.7	0.16	592	1238
8/08/66	114.8	4.0	124.0	103.3	3.6	0.25	544	946
8/15/66	88.4	00.0	145.0	109.5	3.5	0.49	750	1108
8/22/66	20.4	00.0	113.4	Trace	3.3	0.30	192	3434
8/29/66	157.2	00.0	133.6	107.4	3.7	0.18	592	932

Remarks:

Station 15, Saline River above New Cambria

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		8.30	27°C	2000	393.2	16.4	125.7	36.0
6/20/66		7.88	27°C	1800	455.0	16.1	93.0	25.0
6/27/66		7.80	25°C	1700	217.5	16.0	105.0	22.0
7/04/66		7.86	30°C	1480	200.0	18.5	87.0	19.5
7/11/66		7.85	30°C	3000	375.0	22.0	101.3	28.0
7/18/66		7.70	28°C	2500	357.5	23.0	116.0	34.5
7/25/66		7.38	27°C	810	120.0	16.0	59.5	9.5
8/01/66		8.03	29°C	2060	237.5	22.0	78.8	17.0
8/08/66		7.87	26°C	1290	115.0	17.0	85.0	12.5
8/15/66		7.95	26°C	2320	345.0	20.7	93.8	23.8
8/22/66		7.63	21°C	160	5.7	6.2	20.0	2.0
8/29/66		7.67	25°C	1240	175.0	15.5	71.2	11.0

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	560.0	0.0	238.0	259.7	1.8	0.00	1584	1920
6/20/66	525.5	8.8	193.2	235.4	2.3	0.15	1470	1640
6/27/66	289.0	2.8	218.2	129.7	2.2	0.00	990	1224
7/04/66	251.0	3.6	192.4	139.1	1.5	0.06	908	1114
7/11/66	546.2	4.8	181.4	260.5	1.9	0.18	1594	1696
7/18/66	553.6	0.0	195.0	247.0	2.2	0.10	1630	1810
7/25/66	158.2	0.0	107.6	90.6	3.0	0.30	556	1224
8/01/66	428.0	7.2	132.8	177.4	2.5	0.20	1176	1444
8/08/66	229.6	4.0	157.2	115.2	2.4	0.13	780	976
8/15/66	486.0	6.0	155.6	229.7	2.4	0.07	1442	1612
8/22/66	4.8	0.0	90.6	TRACE	3.4	0.30	148	3400
8/29/66	228.8	0.0	153.0	118.1	3.9	0.19	772	1500

Remarks:

Station 16 Solomon River at Niles

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	90 cfs	8.35	26°C	2100	196.6	16.2	105.0	32.0
6/20/66	80 cfs	7.95	24°C	1200	182.5	14.3	102.8	19.5
6/27/66	65 cfs	8.10	28°C	1600	232.5	20.5	98.0	25.0
7/04/66	65 cfs	8.04	28°C	790	82.0	20.0	65.7	12.0
7/11/66	30 cfs	8.02	32°C	1100	92.5	20.0	91.0	16.5
7/18/66	40 cfs	7.60	30°C	2000	282.5	24.0	100.0	30.5
7/25/66	50 cfs	7.53	29°C	600	67.0	10.8	43.8	8.0
8/01/66	135 cfs	7.50	29°C	760	82.0	14.0	47.0	7.5
8/08/66	60 cfs	7.86	25°C	1210	97.5	18.7	82.5	14.3
8/15/66	45 cfs	7.82	22°C	1240	163.0	15.5	79.5	17.3
8/22/66	4,800 cfs	7.57	21°C	180	7.8	6.0	20.0	2.0
8/29/66	180 cfs	7.46	22°C	340	20.5	11.2	45.0	5.1

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	401.0	0.0	317.0	213.6	1.8	0.14	1320	1812
6/20/66	172.6	10.0	200.0	165.1	1.6	0.26	772	1028
6/27/66	277.0	12.0	208.0	190.2	2.2	0.19	1048	1300
7/04/66	93.6	8.8	166.6	71.6	4.9	0.39	514	858
7/11/66	154.8	12.0	201.4	120.6	1.9	0.34	686	866
7/18/66	427.6	0.0	222.0	194.3	1.9	0.21	1392	1598
7/25/66	83.4	0.0	118.2	48.6	3.2	0.38	434	1288
8/01/66	102.0	0.0	130.0	66.7	4.4	0.33	440	1964
8/08/66	178.6	5.6	167.2	157.6	1.7	0.09	804	1032
8/15/66	186.2	2.8	203.4	123.5	2.1	0.10	814	1070
8/22/66	6.6	0.0	97.6	TRACE	3.6	0.20	274	5550
8/29/66	20.0	0.0	131.4	44.4	4.7	0.20	262	1838

Remarks:

Station 17 Salt Creek at Minneapolis

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		8.25	25°C	5000	816.0	16.6	108.0	47.0
6/20/66		8.10	30°C	4000	852.5	14.7	107.5	35.5
6/27/66		8.23	28°C	4000	662.5	19.5	100.0	38.0
7/04/66		7.66	25°C	3910	682.5	20.8	65.7	36.0
7/11/66		7.73	29°C	4000	675.0	20.8	75.0	35.0
7/18/66		7.65	29°C	5500	987.5	27.8	107.2	61.5
7/25/66		7.43	27°C	1200	192.5	16.5	59.5	14.0
8/01/66		7.43	28°C	950	77.5	14.5	48.8	10.0
8/08/66		7.81	21°C	1870	212.5	16.8	87.5	19.3
8/15/66		7.76	26°C	2150	335.0	13.8	78.8	22.5
8/22/66		7.10	20°C	240	26.0	8.8	20.0	2.0
8/29/66		7.60	23°C	1530	210.0	17.8	100.0	16.0

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	1025.6	00.0	327.4	303.3	5.9	0.10	2576	2882
6/20/66	1037.8	20.0	283.4	300.9	2.8	0.18	2460	2740
6/27/66	978.7	22.0	267.0	277.4	3.1	0.07	2468	2730
7/04/66	898.6	00.0	252.2	255.6	2.2	0.44	2388	2734
7/11/66	1330.9	00.0	278.4	257.3	2.2	0.20	2234	3020
7/18/66	1324.2	00.0	184.0	537.5	2.6	0.06	3350	3652
7/25/66	216.8	00.0	155.6	91.4	2.1	0.27	764	1164
8/01/66	141.6	00.0	152.4	74.1	3.1	0.19	604	1204
8/08/66	345.2	4.8	241.2	152.7	2.2	0.16	1150	1304
8/15/66	440.6	00.0	244.0	151.9	2.2	0.05	1342	1600
8/22/66	28.4	00.0	65.6	12.8	3.3	0.40	204	2598
8/29/66	269.0	00.0	247.0	115.7	2.4	0.18	944	1266

Remarks:

Station 18 Solomon River below Glen Elder Dam

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	5.0 cfs	8.20	26°C	800	45.3	15.8	96.0	16.6
6/20/66	1.5 cfs	8.20	28°C	1000	105.0	16.1	125.0	17.5
6/27/66	25.0 cfs	7.56	24°C	360	13.0	13.3	82.0	7.5
7/04/66	6.0 cfs	7.90	24°C	1370	160.0	24.0	94.8	22.0
7/11/66	2.0 cfs	7.70	28°C	560	44.0	18.5	63.5	8.5
7/18/66	00.0 cfs	7.67	28°C	3000	462.5	28.0	116.2	47.0
7/25/66	2.0 cfs	7.64	26°C	800	65.0	18.8	75.0	19.0
8/01/66	3.0 cfs	7.83	27°C	670	38.3	18.5	76.0	12.0
8/08/66	0.2 cfs	7.91	20°C	1930	195.0	23.8	113.8	26.0
8/15/66	3.0 cfs	8.04	24°C	770	53.0	16.3	88.8	15.3
8/22/66	220.0 cfs	7.59	20°C	250	8.6	11.3	35.4	3.2
8/29/66	50.0 cfs +	7.97	22°C	880	73.0	17.0	105.0	16.0
9/12/66		8.40	21°C	930			127.5	17.5
9/19/66		8.17	18°C	820			120.0	15.0
10/03/66		8.07					117.5	20.0
10/31/66							112.5	21.2

Date	Cl mg/L	Alkalinity mg/L		SO_4 mg/L	NO_3 mg/L	PO_4 mg/L	Residue mg/L	
		CO_3	HCO_3				Soluble	Total
6/13/66	48.7	00.0	210.6	123.5	7.0	0.31	590	920
6/20/66	87.2	22.0	214.6	172.05	4.3	0.46	676	774
6/27/66	602.4	00.0	101.0	Trace	4.7	0.53	250	6234
7/04/66	193.4	5.6	194.4	176.6	2.2	0.31	872	970
7/11/66	44.4	00.0	294.6	79.9	5.0	0.82	376	3472
7/18/66	589.2	00.0	266.0	374.1	2.0	0.11	1884	2002
7/25/66	72.0	00.0	128.6	147.8	1.6	0.16	524	744
8/01/66	44.4	2.4	184.6	98.4	4.8	0.42	420	1060
8/08/66	309.8	00.0	238.0	261.0	2.1	0.11	1182	1372
8/15/66	56.4	7.6	185.0	94.7	2.5	0.10	612	742
8/22/66	9.0	00.0	136.6	25.9	4.5	0.40	188	3306
8/29/66	69.0	2.0	195.8	156.8	3.3	0.22	590	832
9/12/66	76.4	28.0	185.0	151.9	5.3	0.22	606	824
9/19/66	59.8	16.0	186.8	127.2	6.3	0.42	526	704
10/03/66	106.5	16.0	206.4	158.0	4.8	0.30	718	782

\+ Glen Elder Outflow

Remarks: SH-18

The measured chloride concentration for the July 27, 1966 sample is significantly greater than the expected value. It is not possible to obtain a balance between the measured anions and cations in the sample. Contamination of the sample container with hydrochloric acid is the suspected cause of the error. This analysis should not be used in any subsequent mathematical analyses.

Station 19 Saline River at Tescott

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	13 cfs	7.60	27°C	700	74.0	9.5	71.0	12.6
6/20/66	7 cfs	7.56	27°C	1800	492.5	17.4	111.0	25.0
6/27/66	5 cfs	7.50	27°C	2950	425.0	19.5	101.0	29.0
7/04/66	8 cfs	7.90	29°C	4170	650.0	29.0	102.5	42.0
7/11/66	6 cfs	7.67	28°C	3800	640.0	27.0	100.2	37.0
7/18/66	5 cfs	7.38	28°C	2500	468.8	26.5	93.2	37.0
7/25/66	10 cfs	8.05	29°C	2800	517.5	26.0	101.2	38.0
8/01/66	16 cfs	7.90	29°C	2410	295.0	22.0	76.0	22.0
8/08/66	8 cfs	7.79	24°C	2870	362.5	23.8	108.8	28.5
8/15/66	30 cfs	7.50	24°C	1320	167.5	15.0	73.8	13.8
8/22/66	125 cfs	7.34	21°C	450	48.0	9.5	20.0	4.4
8/29/66	25 cfs	7.63	24°C	1090	130.0	15.0	82.5	10.9

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	196.2	00.0	180.0	77.8	2.8	0.00	482	844
6/20/66	735.3	00.0	169.6	343.7	2.1	0.00	1604	1758
6/27/66	609.1	00.0	162.0	270.8	2.2	0.10	1662	1822
7/04/66	999.8	4.4	164.8	382.8	1.8	0.08	2554	2670
7/11/66	790.3	00.0	155.0	378.7	1.9	0.08	2286	2414
7/18/66	651.2	00.0	176.0	306.2	2.6	1.04	1858	1948
7/25/66	716.8	10.0	172.2	310.8	2.7	0.25	1964	2172
8/01/66	494.8	3.2	140.6	228.0	2.3	0.04	1412	1644
8/08/66	612.4	4.0	181.6	292.6	2.3	0.16	1730	1866
8/15/66	244.6	00.0	139.0	123.1	3.3	0.43	862	1088
8/22/66	67.0	00.0	97.2	32.1	3.8	0.40	304	3838
8/29/66	190.6	00.0	154.2	103.3	4.5	0.23	678	956

Remarks:

Station 20 Saline River at Sylvan Grove

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66		8.20	26°C	3400	890.2	21.2	118.0	60.0
6/20/66		7.65	25°C	2800	797.5	22.6	112.0	40.0
6/27/66		7.65	23°C	3500	567.5	20.0	116.0	35.0
7/04/66		7.91	27°C	3400	562.5	26.5	100.0	35.5
7/11/66		7.99	27°C	3700	540.0	26.0	100.7	35.0
7/18/66		7.81	28°C	2700	450.0	26.5	106.0	35.5
7/25/66		7.90	27°C	3000	455.0	26.0	111.2	39.0
8/01/66		7.75	28°C	2960	377.5	24.0	91.0	30.0
8/08/66		7.44	18°C	1040	85.0	14.7	62.5	8.8
8/15/66		7.70	24°C	2630	400.0	21.8	109.0	28.8
8/22/66		7.52	21°C	640	72.5	11.8	48.4	5.2
8/29/66		7.82	23°C	2730	412.5	22.5	116.2	30.0
9/12/66		8.10	21°C	2700			125.0	32.0
9/19/66		8.20	18°C	2780			137.5	29.2
10/03/66		8.03					121.2	32.5
10/31/66							112.5	36.7

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	1350.3	00.0	210.4	423.5	1.9	0.02	2956	3024
6/20/66	1025.9	00.0	165.6	377.8	2.4	0.06	2478	2564
6/27/66	819.3	00.0	156.0	323.9	1.9	0.01	2092	2270
7/04/66	793.6	5.6	140.0	309.1	1.5	0.00	2058	2168
7/11/66	820.0	7.6	127.8	339.2	1.7	0.07	2110	2168
7/18/66	648.8	0.8	145.2	281.9	2.3	0.00	1778	1850
7/25/66	750.6	6.8	131.2	297.2	2.4	0.13	1842	1902
8/01/66	649.6	00.0	162.4	287.3	2.3	0.04	1744	1838
8/08/66	196.4	00.0	114.2	103.7	4.2	0.21	650	2304
8/15/66	563.2	00.0	181.0	269.6	2.3	0.13	1662	1858
8/22/66	107.4	00.0	242.8	51.0	4.4	0.10	406	5094
8/29/66	592.8	3.6	173.2	275.4	2.2	0.00	1692	1774
9/12/66	599.8	12.0	160.0	270.4	2.2	0.04	1618	1798
9/19/66	608.6	12.0	166.2	277.4	2.2	0.10	1634	1766
10/03/66	647.5	8.8	173.6	267.5	2.8	0.07	1748	1836
10/31/66								

Remarks:

Station 21 Smoky Hill River near Mentor

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	100 cfs	8.15	24°C	825	71.2	11.6	96.0	18.8
6/20/66	640 cfs	7.35	23°C	800	110.0	11.5	94.0	13.0
6/27/66	75 cfs	7.89	25°C	1000	68.0	11.3	101.0	15.5
7/04/66	60 cfs	7.89	26°C	950	82.0	16.5	91.0	15.0
7/11/66	50 cfs	7.98	26°C	975	83.0	14.8	100.0	16.0
7/18/66	25 cfs	7.75	27°C	940	76.0	17.3	102.0	21.0
7/25/66	45 cfs	7.75	27°C	675	62.0	13.5	72.5	13.5
8/01/66	780 cfs	7.55	28°C	900	70.0	12.8	77.5	12.0
8/08/66	550 cfs	7.70	26°C	770	64.5	12.8	77.5	9.9
8/15/66	230 cfs	7.53	26°C	630	47.5	10.3	63.5	9.0
8/22/66	475 cfs	7.76	23°C	740	65.0	11.8	65.6	8.6
8/29/66	510 cfs	7.70	24°C	700	66.0	11.2	73.0	8.8

Date	Cl mg/L	Alkalinity mg/L		SO_4	NO_3	PO_4	Residue mg/L	
		CO_3	HCO_3	mg/L	mg/L	mg/L	Soluble	Total
6/13/66	137.1	00.0	170.0	129.2	2.7	0.00	612	1392
6/20/66	136.3	00.0	112.8	119.4	3.1	0.00	584	1124
6/27/66	136.2	3.6	134.4	127.2	1.8	0.00	636	852
7/04/66	128.0	4.0	124.2	116.5	1.6	0.00	640	740
7/11/66	131.7	6.0	144.4	142.4	1.4	0.09	626	738
7/18/66	126.0	00.0	163.0	126.8	1.5	0.09	670	750
7/25/66	82.0	00.0	136.4	81.5	5.2	0.25	456	826
8/01/66	129.2	00.0	148.4	105.4	3.5	0.05	552	1124
8/08/66	108.8	00.0	121.2	99.2	2.8	0.09	536	844
8/15/66	81.0	00.0	141.0	63.0	2.9	0.31	426	1356
8/22/66	108.8	00.0	139.6	87.3	3.6	0.10	512	900
8/29/66	101.0	00.0	127.0	78.6	3.6	0.00	466	744

Remarks:

Station 22 Smoky Hill River near Langley

Date	Discharge CFS	pH	Temp. °C	Specific Conductance Micromhos at 25°C	Na mg/L	K mg/L	Ca mg/L	Mg mg/L
6/13/66	275 cfs	8.00	23°C	850	75.7	10.8	96.0	16.6
6/20/66	475 cfs	7.76	25°C	740	110.0	11.5	98.0	13.0
6/27/66	85 cfs	7.50	23°C	940	56.0	10.7	95.0	14.0
7/04/66	80 cfs	7.96	24°C	900	75.0	15.8	84.8	12.0
7/11/66	65 cfs	8.05	26°C	925	80.0	14.0	91.0	19.0
7/18/66	50 cfs	7.80	28°C	875	75.0	16.8	91.0	19.0
7/25/66	155 cfs	7.87	27°C	825	86.0	14.8	87.5	15.5
8/01/66	850 cfs	7.69	27°C	810	63.0	12.3	73.5	11.0
8/08/66	700 cfs	7.93	26°C	750	64.5	12.8	77.5	10.5
8/15/66	150 cfs	7.70	24°C	760	64.0	10.5	78.3	10.8
8/22/66	170 cfs	7.87	24°C	750	65.5	11.8	66.0	8.4
8/29/66	525 cfs	7.70	24°C	710	68.0	11.0	73.0	8.5
9/12/66		8.00	23°C	750			81.2	9.4
9/19/66		7.98	21°C	720			100.0	9.0
10/03/66		7.88					77.5	9.0
10/31/66							83.7	11.2

Date	CL mg/L	Alkalinity mg/L		SO_4 mg/L	NO_3 mg/L	PO_4 mg/L	Residue mg/L	
		CO_3	HCO_3				Soluble	Total
6/13/66	151.5	0.0	166.4	120.2	1.5	0.00	698	754
6/20/66	137.6	0.0	114.2	113.6	2.7	0.00	616	660
6/27/66	125.5	0.0	119.2	115.7	3.0	0.00	608	660
7/04/66	127.2	6.0	111.0	104.5	3.1	0.00	614	646
7/11/66	130.0	6.0	114.2	123.5	3.0	0.12	614	646
7/18/66	130.6	1.2	121.6	112.8	3.3	0.13	628	672
7/25/66	130.0	5.2	110.2	119.0	3.4	0.04	640	678
8/01/66	118.4	0.0	103.4	90.1	3.5	0.05	502	654
8/08/66	109.0	5.2	104.8	94.7	3.3	0.13	518	610
8/15/66	106.4	0.0	112.2	89.3	3.5	0.11	520	640
8/22/66	109.6	1.6	108.8	84.4	3.6	0.10	488	518
8/29/66	104.4	0.0	106.0	76.6	3.6	0.08	470	514
9/12/66	98.0	6.0	105.0	75.3	3.9	0.15	524	606
9/19/66	99.5	5.6	111.4	74.0	3.5	0.20	460	756
10/03/66	107.5	4.0	112.0	56.4	3.6	0.20	446	580
10/31/66								

Remarks:

Mathematical Analyses

The data collected under this contract and the grab sample data available from the water quality monitoring program conducted jointly by the United States Geological Survey and the Kansas State Department of Health has been used to investigate a series of mathematical relationships.

The interrelationships between the ions in solution at each sampling site has been evaluated by computing the linear correlation coefficient between each of the parameters analyzed. These correlations were computed by the following formula:

$$r_{ij} = \frac{\Sigma x_i x_j - \Sigma x_i \Sigma x_j / N}{\{\Sigma x_i^2 - (\Sigma x_i)^2/N\}^{\frac{1}{2}} \{\Sigma x_j^2 - (\Sigma x_j)^2/N\}^{\frac{1}{2}}}$$

where N = number of observations

and are summarized in a two-way matrix for each location. This technique facilitated the rapid characterization of the water type at each site and in those locations where previous analyses exist if permitted rapid comparison of the data.

It is not surprising that the parameters which have the greatest correlation with the majority of other ions in solution are the total dissolved solids and the specific conductance. The specific conductance is easily measured on a continuous basis and would therefore be attractive as a monitor for the mathematical model being developed under the original contract.

Prediction equations for each of the dissolved ions as a function of specific conductance were therefore established by linear regression and are tabulated for each station. The standard deviation squared, or standard error of estimate squared, as computed by the equation

$$SE^2 = \frac{\Sigma(Y - Ye)^2}{N - 2}$$

where Ye = the expected value of Y

is also tabulated so that confidence intervals for each of the regression equations may be calculated.

The following regression equations between discharge and each individual parameter were also investigated:

$$Q = a + bX$$

$$Q = aX^b$$

$$Q = 10^{(a + bX)}$$

$$Q = a + 1/X$$

$$Q = a + b(\log X)$$

$$Q = a + b/\log X$$

where

Q = discharge in cubic feet per second

X = the concentration of the individual parameter

a and b = constants.

The equations giving the highest correlation coefficient between discharge versus chloride concentration, discharge versus sulfate

concentration, discharge versus total dissolved solids, and discharge versus specific conductance are tabulated in this report.

Notation

The following notation is used in the tables:

Na = sodium concentration in milligrams per liter

K = potassium concentration in milligrams per liter

Ca = calcium concentration in milligrams per liter

Mg = magnesium concentration in milligrams per liter

Cl = chloride concentration in milligrams per liter

HCO_3= bicarbonate concentration in milligrams per liter as $CaCO_3$

SO_4= sulfate concentration in milligrams per liter

TDS = total dissolved solids in milligrams per liter

SC = specific conductance in micromhos per centimeter at 25°C

cfs = discharge in cubic feet per second.

Station 1 Kansas River at Kansas City

Linear Correlation Coefficients

KSGS-KSHD **Summer 1966** **12 Observations**

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	0.8208	0.7877	0.8667	0.9122	0.5714	0.9255	0.9621	0.9688	1
	1.0000	0.4028	0.5890	0.3025	0.2836	0.8223	0.7788	0.7767	2
		1.0000	0.9044	0.6703	0.7805	0.7086	0.8163	0.8414	3
			1.0000	0.8136	0.7182	0.8345	0.9303	0.9321	4
				1.0000	0.4525	0.8005	0.9027	0.9429	5
					1.0000	0.5843	0.6625	0.6531	6
						1.0000	0.9420	0.9098	7
							1.0000	0.9825	8
								1.0000	9

Station 1 Kansas River at Kansas City

Regression Against Specific Conductance

KSGS-KSHD **Summer 1966**

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	52.1	Na = -17.00 + 0.1089 SC	23.6
K	9.9	K = 0.203 + 0.0153 SC	4.7
Ca	66.1	Ca = 15.50 + 0.0798 SC	80.2
Mg	12.6	Mg = -3.75 + 0.0258 SC	3.1
Cl	61.8	Cl = -27.53 + 0.1408 SC	74.5
HCO_3	134.7	HCO_3= 81.11 + 0.0844 SC	292.1
SO_4	74.9	SO_4= 3.26 + 0.1129 SC	80.9
TDS	464.3	TDS = 58.56 + 0.6394 SC	448.9
SC	634.6		

Station 2 Kansas River at Bonner Springs

Linear Correlation Coefficients

KSGS-KSHD **Summer 1966** **12 Observations**

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.7565	0.5267	0.7895	0.9122	0.1953	0.8723	0.7979	0.9815	1
	1.0000	0.3603	0.6137	0.6218	0.0524	0.6506	0.4988	0.7022	2
		1.0000	0.7401	0.1631	0.8488	0.6900	0.4204	0.4612	3
			1.0000	0.5792	0.3856	0.8503	0.6720	0.7633	4
				1.0000	-0.1390	0.7211	0.7804	0.9415	5
					1.0000	0.2932	0.2314	0.1542	6
						1.0000	0.7565	0.8494	7
							1.0000	0.8651	8
								1.0000	9

Kansas River at Bonner Springs 6-8925

USGS-KSHD **October 1961 - May 1964** **46 Observations**

1.0000	0.	0.7783	0.7659	0.9785	0.6962	0.9228	0.9377	0.8625	1
		1.0000	0.9447	0.7797	0.9833	0.9110	0.9341	0.7841	3
			1.0000	0.7633	0.9341	0.9044	0.9120	0.7611	4
				1.0000	0.6824	0.9153	0.9419	0.8706	5
					1.0000	0.8546	0.8766	0.7176	6
						1.0000	0.9828	0.8605	7
							1.0000	0.8767	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD **Summer 1966**

Parameter	Mean of Observations	Equation Regression	One Standard Deviation
Na	49.9	Na = -18.32 + 0.1121 SC	20.6
K	9.8	K = 2.22 + 0.0124 SC	6.8
Ca	61.1	Ca = 41.39 + 0.0323 SC	166.0
Mg	11.6	Mg = 3.83 + 0.0127 SC	5.0
Cl	62.7	Cl = -59.95 + 0.2014 SC	223.8
HCO_3	128.4	HCO_3= 122.4 + 0.0099 SC	172.8
SO_4	66.8	SO_4= -4.94 + 0.1178 SC	230.6
TDS	462.5	TDS = 141.1 + 0.5276 SC	4029.0
SC	60.9		
USGS-KSHD		**October 1961 - May 1964**	
Na	65.0	Na = -12.92 + 0.0990 SC	334.3
Ca	80.3	Ca = 28.72 + 0.0656 SC	267.2
Mg	17.2	Mg = 4.22 + 0.0165 SC	19.6
Cl	81.4	Cl = -18.30 + 0.1267 SC	508.0
HCO_3	237.8	HCO_3= 114.8 + 0.1564 SC	2284.0
SO_4	100.5	SO_4= -5.30 + 0.1345 SC	628.3
TDS	498.6	TDS = 81.17 + 0.5306 SC	8398.0
SC	786.3		

Station 2 Kansas River at Bonner Springs

Regression Against Discharge

KSGS-KSHD

Summer 1966

Discharge Range 1,800 - 36,000 cfs

Regression Equation	Correlation Coefficient
$Cl = -15.61 + 40.98/\log Q$	0.7892
$SO_4 = -31.94 + 71.58/\log Q$	0.6995

All regressions of total dissolved solids against discharge at this station have a correlation coefficient of less than 0.6500.

$SC = -492.60 + 917.4/\log Q$	0.7456

Ten of the twelve observations used in developing these regression equations had observed discharges between 1,800 and 3,400 cubic feet per second.

Station 3 Wakarusa River at Eudora

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	-0.0981	0.8407	0.8326	0.9199	0.9083	0.5766	0.8812	0.8258	1
	1.0000	-0.0535	0.1135	-0.0751	-0.1921	0.1318	-0.0505	0.0747	2
		1.0000	0.9475	0.7752	0.9355	0.5938	0.9833	0.9275	3
			1.0000	0.8335	0.9069	0.6046	0.9506	0.9618	4
				1.0000	0.8793	0.3702	0.8237	0.8748	5
					1.0000	0.5091	0.9637	0.9258	6
						1.0000	0.6171	0.5108	7
							1.0000	0.9528	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	10.3	Na = -3.00 + 0.0366 SC	7.5
K	8.5	K = 4.70 + 0.0105 SC	237.0
Ca	62.1	Ca = -1.10 + 0.1733 SC	58.6
Mg	8.7	Mg = -1.53 + 0.0281 SC	0.6
Cl	8.4	Cl = -5.52 + 0.0381 SC	5.3
HCO_3	143.8	HCO_3 = 1.05 + 0.3915 SC	306.5
SO_4	27.2	SO_4 = 3.95 + 0.0637 SC	138.0
TDS	245.3	TDS = 40.33 + 0.5623 SC	388.0
SC	364.6		

Station 4 Kansas River at Lawrence

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	0.7744	0.8826	0.8749	0.9871	0.8325	0.9671	0.9555	0.9845	1
	1.0000	0.6175	0.7153	0.7335	0.6306	0.7961	0.7919	0.7713	2
		1.0000	0.8833	0.8567	0.8948	0.9141	0.9076	0.9150	3
			1.0000	0.8453	0.8011	0.8456	0.9281	0.9257	4
				1.0000	0.7846	0.9446	0.9244	0.9679	5
					1.0000	0.8507	0.9020	0.8628	6
						1.0000	0.9532	0.9542	7
							1.0000	0.9793	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	49.4	Na = -15.53 + 0.1079 SC	20.5
K	10.1	K = 2.17 + 0.0132 SC	6.6
Ca	61.1	Ca = 16.87 + 0.0736 SC	58.4
Mg	11.3	Mg = 0.88 + 0.0174 SC	2.8
Cl	57.6	Cl = -26.14 + 0.1392 SC	72.3
HCO_3	127.5	HCO_3 = 72.97 + 0.0907 SC	156.4
SO_4	65.7	SO_4 = -16.3 + 0.1364 SC	101.4
TDS	421.7	TDS = 60.49 + 0.6007 SC	853.9
SC	601.3		

Station 5 Kansas River near Lecompton

Linear Correlation Coefficients

KSGS-KSHD — Summer 1966 — 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.8673	0.6310	0.7761	0.9739	0.4353	0.9704	0.9584	0.9448	1
	1.0000	0.3232	0.5326	0.8755	0.1128	0.8207	0.8002	0.7504	2
		1.0000	0.8734	0.5856	0.9564	0.7578	0.7787	0.8204	3
			1.0000	0.6721	0.7635	0.8732	0.9041	0.8901	4
				1.0000	0.3872	0.9243	0.9126	0.9094	5
					1.0000	0.5889	0.6089	0.6753	6
						1.0000	0.9814	0.9773	7
							1.0000	0.9791	8
								1.0000	9

USGS-KSHD — October 1957 - September 1964 — 46 Observations

1.0000	0.8165	0.8453	0.9932	0.7763	0.9384	0.9635	0.9666	1
	1.0000	0.8813	0.8008	0.9731	0.9177	0.9307	0.9255	3
		1.0000	0.8385	0.8929	0.9172	0.9242	0.9170	4
			1.0000	0.7511	0.9306	0.9560	0.9594	5
				1.0000	0.8639	0.8968	0.8876	6
					1.0000	0.9815	0.9834	7
						1.0000	0.9968	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD — Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	35.6	Na = -16.35 + 0.1005 SC	48.2
K	8.4	K = 0.57 + 0.0151 SC	7.1
Ca	61.1	Ca = 15.57 + 0.0881 SC	149.5
Mg	11.1	Mg = 1.03 + 0.0194 SC	3.9
Cl	39.8	Cl = -24.98 + 0.1253 SC	130.4
HCO_3	140.6	HCO_3 = 70.55 + 0.1355 SC	869.2
SO_4	53.0	SO_4 = -22.86 + 0.1466 SC	40.1
TDS	369.2	TDS = 33.09 + 0.6499 SC	724.9
SC	517.1		

USGS-KSHD — October 1957 - September 1964

Na	67.3	Na = -27.87 + 0.1140 SC	89.6
Ca	79.9	Ca = 16.96 + 0.0754 SC	93.1
Mg	18.0	Mg = 1.34 + 0.0200 SC	7.3
Cl	87.3	Cl = -41.02 + 0.1537 SC	200.1
HCO_3	238.5	HCO_3 = 80.59 + 0.1893 SC	945.2
SO_4	103.9	SO_4 = -18.19 + 0.1462 SC	71.2
TDS	506.5	TDS = - 7.84 + 0.6162 SC	237.6
SC	834.6		

Station 5 Kansas River at Lecompton

Regression Against Discharge

KSGS-KSHD Summer 1966

Discharge Range 1,700 - 35,000 cfs

Regression Equation	Correlation Coefficient
$CL = 1{,}538{,}000Q^{-1.392}$	0.9582
$SO_4 = 1{,}170{,}000Q^{-1.307}$	-0.9863
$TDS = 1.384Q^{0.8951}$	0.9914
$SC = -95.15 + 266.8/\log Q$	0.9926

Ten of the twelve observations used in developing these regression equations had observed discharges between 1,700 and 3,300 cubic feet per second.

Station 6 Delaware River at Perry

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.3930	0.8211	0.8758	0.8701	0.8651	0.8936	0.8897	0.9235	1
	1.0000	0.2461	0.3040	0.4610	0.1371	0.3933	0.2661	0.5072	2
		1.0000	0.9410	0.6751	0.9640	0.9412	0.9453	0.9063	3
			1.0000	0.6559	0.9444	0.9348	0.9072	0.9413	4
				1.0000	0.6521	0.7552	0.7276	0.7740	5
					1.0000	0.9227	0.9415	0.8923	6
						1.0000	0.9354	0.9662	7
							1.0000	0.9290	8
								1.0000	9

USGS-KSHD October 1961 - September 1964 36 Observations

1.0000	0.4780	0.4440	0.9612	0.4233	0.8599	0.7445	0.6766	1
	1.0000	0.7560	0.3603	0.9705	0.5483	0.9115	0.9417	3
		1.0000	0.3998	0.8227	0.5786	0.8284	0.8316	4
			1.0000	0.2950	0.8367	0.6604	0.5892	5
				1.0000	0.4562	0.8895	0.9237	6
					1.0000	0.7751	0.7080	7
						1.0000	0.9775	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	13.5	Na = - 1.45 + 0.0359 SC	39.7
K	4.7	K = 2.18 + 0.0061 SC	1.9
Ca	67.4	Ca = - 5.67 + 0.1753 SC	119.5
Mg	11.0	Mg = - 1.63 + 0.0302 SC	2.1
Cl	10.0	Cl = - 1.80 + 0.0284 SC	9.6
HCO_3	158.3	HCO_3= 14.20 + 0.3458 SC	547.6
SO_4	31.8	SO_4= - 10.52 + 0.1016 SC	13.1
TDS	286.0	TDS = 69.78 + 0.5189 SC	764.1
SC	416.7		

USGS-KSHD October 1961 - September 1964

Na	23.9	Na = - 4.27 + 0.0454 SC	45.9
Ca	83.9	Ca = 3.96 + 0.1287 SC	39.7
Mg	19.4	Mg = - 1.80 + 0.0340 SC	9.7
Cl	19.3	Cl = - 7.88 + 0.0437 SC	67.5
HCO_3	307.4	HCO_3= 6.59 + 0.4843 SC	757.1
SO_4	58.8	SO_4= - 2.30 + 0.0984 SC	180.9
TDS	379.1	TDS = 13.56 + 0.5885 SC	303.3
SC	621.1		

Station 7 Kansas River at Topeka

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	-0.0292	0.5979	0.5907	0.9476	-0.0016	0.5950	0.8947	0.7950	1
	1.0000	0.3481	0.4949	0.0885	-0.1387	0.4416	0.1753	0.3626	2
		1.0000	0.7651	0.7685	0.4350	0.3487	0.7279	0.9067	3
			1.0000	0.6842	0.0858	0.5883	0.8476	0.8723	4
				1.0000	0.0340	0.5862	0.9231	0.8969	5
					1.0000	-0.4961	0.0193	0.1384	6
						1.0000	0.06754	0.6336	7
							1.0000	0.9213	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	57.6	Na = - 38.39 + 0.1478 SC	185.6
K	11.7	K = 6.38 + 0.0083 SC	6.6
Ca	60.2	Ca = - 6.18 + 0.1023 SC	33.0
Mg	13.3	Mg = - 3.57 + 0.0260 SC	3.1
Cl	73.9	Cl = - 59.24 + 0.2050 SC	149.0
HCO_3	135.7	HCO_3 = 127.3 + 0.0131 SC	127.4
SO_4	77.2	SO_4 = - 23.90 + 0.1558 SC	528.1
TDS	463.3	TDS = - 30.01 + 0.7600 SC	1502.0
SC	649.2		

Regression Against Discharge

KSGS-KSHD Summer 1966

Discharge Range 800 - 3,000 cfs

All regressions against discharge at this station have a correlation coefficient of less than o.6500.

Station 8 Kansas River at Wamego

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	0.0803	0.8424	0.8665	0.9961	0.7193	0.9475	0.9861	0.9869	1
	1.0000	0.0057	0.2824	0.0663	0.1488	0.0069	0.1211	0.1415	2
		1.0000	0.8681	0.8559	0.7225	0.9495	0.8661	0.8663	3
			1.0000	0.8786	0.6202	0.9048	0.9080	0.9020	4
				1.0000	0.6833	0.9579	0.9900	0.9903	5
					1.0000	0.6764	0.6764	0.6898	6
						1.0000	0.9696	0.9660	7
							1.0000	0.9962	8
								1.0000	9

USGS-KSHD October 1956 - August 1964 84 Observations

1.0000	0.6994	0.7380	0.9943	0.7374	0.7785	0.9474	0.9569	1
	1.0000	0.8807	0.6841	0.9221	0.9356	0.8795	0.8653	3
		1.0000	0.7226	0.8855	0.9172	0.8767	0.8676	4
			1.0000	0.7145	0.7632	0.9407	0.9515	5
				1.0000	0.8313	0.8799	0.8667	6
					1.0000	0.9147	0.9022	7
						1.0000	0.9969	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	80.9	Na = -54.96 + 0.1644 SC	130.7
K	12.9	K = 12.36 + 0.0006 SC	3.6
Ca	73.0	Ca = 42.16 + 0.0373 SC	84.0
Mg	15.9	Mg = 5.84 + 0.0122 SC	6.2
Cl	101.8	Cl = -54.26 + 0.1888 SC	127.3
HCO_3	154.5	HCO_3 = 114.2 + 0.0487 SC	474.3
SO_4	87.1	SO_4 = 9.40 + 0.0940 SC	114.8
TDS	566.1	TDS = 51.69 + 0.6223 SC	537.4
SC	826.7		

USGS-KSHD October 1956 - August 1964

Na	77.1	Na = -32.02 + 0.1278 SC	216.4
Ca	75.8	Ca = 27.09 + 0.0571 SC	157.3
Mg	16.1	Mg = 1.56 + 0.0171 SC	13.7
Cl	102.9	Cl = -56.69 + 0.1869 SC	526.1
HCO_3	227.5	HCO_3 = 98.94 + 0.1506 SC	1082.0
SO_4	94.0	SO_4 = - 3.65 + 0.1143 SC	429.9
TDS	512.4	TDS = 0.66 + 0.5993 SC	316.8
SC	853.9		

Station 8 Kansas River at Wamego

Regression Against Discharge

KSGS-KSHD

Summer 1966

Discharge Range 1,100 - 2,500 cfs

All regressions against discharge at this station have a correlation coefficient of less than 0.6500.

Station 9 Big Blue River below Tuttle Creek Dam

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	-0.2133	0.2543	-0.2099	-0.0341	0.1725	0.2763	0.5337	-0.1062	1
	1.0000	-0.1189	-0.0869	0.3284	-0.5313	0.2758	-0.5168	-0.4023	2
		1.0000	0.6258	0.3594	0.4879	-0.1522	-0.1910	0.4079	3
			1.0000	0.4364	0.2589	-0.3329	-0.3735	0.5008	4
				1.0000	0.1136	-0.0576	-0.3353	0.4715	5
					1.0000	-0.4993	-0.0216	0.6506	6
						1.0000	-0.1390	-0.3979	7
							1.0000	-0.0586	8
								1.0000	9

USGS-KSHD October 1955 - September 1964 68 Observations

1.0000	0.6297	0.5259	0.9743	0.7377	0.5219	0.8060	0.8046	1
	1.0000	0.9263	0.5218	0.9640	0.9532	0.9526	0.9562	3
		1.0000	0.4296	0.9033	0.9515	0.8899	0.9006	4
			1.0000	0.6502	0.3931	0.7159	0.7202	5
				1.0000	0.9003	0.9635	0.9687	6
					1.0000	0.8980	0.8978	7
						1.0000	0.9931	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	21.8	Na = 25.39 - 0.0080 SC	8.5
K	10.1	K = 20.63 - 0.0234 SC	4.2
Ca	60.4	Ca = 33.62 + 0.0597 SC	26.8
Mg	12.9	Mg = 3.61 + 0.0207 SC	1.9
Cl	18.8	Cl = 8.03 + 0.0241 SC	3.0
HCO_3	154.9	HCO_3= 10.77 + 0.3216 SC	211.0
SO_4	40.5	SO_4= 81.26 - 0.0908 SC	65.6
TDS	346.8	TDS =361.9 - 0.0336 SC	491.4
SC	448.3		

USGS-KSHD October 1955 - September 1964

Na	23.2	Na = - 4.56 + 0.0607 SC	40.8
Ca	53.5	Ca = - 0.26 + 0.1176 SC	26.3
Mg	11.8	Mg = - 2.24 + 0.0307 SC	4.5
Cl	21.1	Cl = - 3.67 + 0.05427 SC	55.5
HCO_3	198.4	HCO_3= 21.30 + 0.3875 SC	200.3
SO_4	41.2	SO_4= -14.94 + 0.1228 SC	73.6
TDS	279.1	TDS = 1.32 + 0.6079 SC	104.6
SC	457.0		

Station 9 Big Blue River below Tuttle Creek Dam

Regression Against Discharge

KSGS-KSHD

Summer 1966

Discharge Range 12 - 1,000 cfs

Regression Equation	Correlation Coefficient

All regressions of chloride, sulfate, and total dissolved solids against discharge at this station have a correlation coefficient of less than 0.6000.

$SC = 565.0Q^{-0.04292}$	0.7302

Station 10 Kansas River at Manhattan

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	0.2519	0.7232	0.6077	0.9571	0.1059	0.8101	0.8890	0.9366	1
	1.0000	0.1917	0.4531	0.2982	-0.1253	0.0615	0.3172	0.3187	2
		1.0000	0.7189	0.8001	0.3942	0.9352	0.8337	0.8273	3
			1.0000	0.7233	0.4517	0.7354	0.8226	0.8005	4
				1.0000	0.1129	0.8733	0.9714	0.9896	5
					1.0000	0.3139	0.1386	0.1806	6
						1.0000	0.9074	0.8918	7
							1.0000	0.9891	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	87.5	Na = -46.14 + 0.1490 SC	167.8
K	14.8	K = 10.73 + 0.0046 SC	9.9
Ca	78.6	Ca = 26.69 + 0.0579 SC	83.4
Mg	15.8	Mg = 1.48 + 0.0159 SC	7.7
Cl	121.4	Cl = -62.32 + 0.2049 SC	48.0
HCO_3	158.8	HCO_3 = 146.3 + 0.0139 SC	311.4
SO_4	101.3	SO_4 = - 4.80 + 0.1184 SC	194.7
TDS	571.8	TDS = 74.30 + 0.5549 SC	369.7
SC	896.7		

Station 11 Republican River below Milford Dam

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	-0.3572	0.5164	0.5518	0.9770	0.4909	0.7609	0.8391	0.8916	1
	1.0000	0.0796	0.1551	-0.3530	0.1213	-0.0952	-0.0911	-0.0726	2
		1.0000	0.8795	0.4076	0.8598	0.9052	0.7477	0.7560	3
			1.0000	0.4593	0.8457	0.8476	0.7968	0.8043	4
				1.0000	0.3774	0.6580	0.8242	0.8625	5
					1.0000	0.8335	0.7356	0.7455	6
						1.0000	0.8546	0.8861	7
							1.0000	0.9758	8
								1.0000	9

USGS-KSHD October 1955 - September 1964 64 Observations

1.0000	0.8089	0.7296	0.9799	0.7711	0.8664	0.9170	0.9400	1
	1.0000	0.8257	0.7756	0.9540	0.9128	0.9672	0.9469	3
		1.0000	0.6614	0.8928	0.8357	0.8624	0.8473	4
			1.0000	0.7128	0.8113	0.8821	0.9099	5
				1.0000	0.8437	0.9343	0.9099	6
					1.0000	0.9489	0.9440	7
						1.0000	0.9908	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	37.4	Na = -13.44 + 0.0875 SC	45.4
K	15.4	K = 16.34 - 0.0017 SC	12.6
Ca	67.1	Ca = 15.71 + 0.0883 SC	134.5
Mg	13.6	Mg = 1.88 + 0.0202 SC	5.1
Cl	37.3	Cl = -54.76 + 0.1582 SC	198.2
HCO_3	163.4	HCO_3= 95.32 + 0.1171 SC	252.0
SO_4	66.8	SO_4= - 9.87 + 0.1318 SC	109.2
TDS	386.0	TDS = 67.96 + 0.5468 SC	344.9
SC	581.7		

USGS-KSHD October 1955 - September 1964

Na	37.6	Na = -18.96 + 0.0898 SC	47.6
Ca	69.8	Ca = 3.45 + 0.1053 SC	57.4
Mg	15.0	Mg = 0.86 + 0.0224 SC	8.9
Cl	37.2	Cl = -30.45 + 0.1074 SC	107.6
HCO_3	239.7	HCO_3= 58.06 + 0.2883 SC	774.6
SO_4	75.2	SO_4= -20.78 + 0.1523 SC	127.1
TDS	391.7	TDS = - 8.50 + 0.6352 SC	337.0
SC	630.1		

Station 11 Republican River Below Milford Dam

Regression Against Discharge

KSGS-KSHD

Summer 1966

Discharge Range 225 - 1,000 cfs

Regression Equation	Correlation Coefficient
$Cl = 10^{(1.077 + 167.8/Q)}$	0.7026
$SO_4 = 10^{(1.587 + 87.74/Q)}$	0.6861
$TDS = 244.5 + 57{,}000/Q$	0.7486
$SC = 298.5 + 114{,}100/Q$	0.8396

Station 12 Smoky Hill River at Junction City

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.7934	0.7864	0.9465	0.9781	-0.0266	0.9358	0.9905	0.9874	1
	1.0000	0.5672	0.7275	0.7828	-0.0279	0.8073	0.7926	0.7848	2
		1.0000	0.8716	0.7533	-0.5034	0.8577	0.7883	0.7850	3
			1.0000	0.9443	-0.1463	0.9435	0.9671	0.9638	4
				1.0000	-0.0338	0.8903	0.9910	0.9946	5
					1.0000	-0.0880	-0.0374	-0.0439	6
						1.0000	0.9321	0.9198	7
							1.0000	0.9984	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	160.3	Na = -40.11 + 0.1395 SC	307.5
K	14.2	K = 8.50 + 0.0039 SC	6.0
Ca	88.4	Ca = 51.21 + 0.0259 SC	256.6
Mg	19.8	Mg = 2.11 + 0.0123 SC	7.2
Cl	258.1	Cl = -84.41 + 0.2384 SC	381.2
HCO_3	294.4	HCO_3 = 332.1 - 0.0262 SC	22×10^4
SO_4	148.8	SO_4 = 48.54 + 0.0698 SC	546.0
TDS	874.0	TDS = 70.91 + 0.5590 SC	603.6
SC	1437.0		

Station 13 Smoky Hill River at Enterprise

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 11 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO 6	SO 7	TDS 8	SC 9	
1.0000	0.7957	0.8211	0.9556	0.9282	0.5856	0.9006	0.9361	0.9366	1
	1.0000	0.8088	0.8886	0.8751	0.3429	0.9085	0.8992	0.9112	2
		1.0000	0.9250	0.8198	0.5485	0.9504	0.8541	0.8553	3
			1.0000	0.9481	0.5396	0.9765	0.9686	0.9692	4
				1.0000	0.4295	0.9031	0.9958	0.9926	5
					1.0000	0.4568	0.4342	0.4135	6
						1.0000	0.9352	0.9424	7
							1.0000	0.9981	8
								1.0000	9

The sample for July 25, 1966 was omitted from these computations

Smoky Hill River at Enterprise 6-8776

USGS-KSHD October 1955 - September 1964 88 Observations

1.0000	0.5976	0.7741	0.9813	0.6786	0.7957	0.9824	0.9859	1
	1.0000	0.6685	0.5965	0.9042	0.8923	0.7258	0.7065	3
		1.0000	0.7664	0.7656	0.8661	0.8361	0.8283	4
			1.0000	0.6605	0.7962	0.9664	0.9679	5
				1.0000	0.8338	0.7773	0.7588	6
					1.0000	0.8828	0.8729	7
						1.0000	0.9974	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	211.4	Na = -18.15 + 0.1528 SC	4474.0
K	14.9	K = 7.27 + 0.0051 SC	7.2
Ca	83.9	Ca = 41.54 + 0.0282 SC	399.3
Mg	16.7	Mg = 4.24 + 0.0083 SC	6.1
Cl	309.7	Cl = -113.70 + 0.2819 SC	1629.0
HCO_3	142.0	HCO_3 = 131.40 + 0.0070 SC	327.1
SO_4	144.8	SO_4 = 42.03 + 0.0684 SC	807.9
TDS	964.4	TDS = 68.32 + 0.5966 SC	1904.0
SC	1502.0		
USGS-KSHD	October 1955 - September 1964		
Na	234.9	Na = -81.66 + 0.1756 SC	874.2
Ca	107.1	Ca = 59.14 + 0.0266 SC	699.9
Mg	24.3	Mg = 5.32 + 0.0105 SC	49.9
Cl	331.1	Cl = -120.90 + 0.2508 SC	4181.0
HCO_3	243.1	HCO_3 = 146.90 + 0.0534 SC	2068.0
SO_4	205.5	SO_4 = 49.88 + 0.0863 SC	2294.0
TDS	1074.0	TDS = -0.02 + 0.5957 SC	1836.0
SC	1803.0		

Station 14 Smoky Hill River at the New Cambria Gage

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	0.6493	0.9090	0.9265	0.8247	0.4207	0.9256	0.9660	0.9578	1
	1.0000	0.6007	0.6888	0.5425	0.4824	0.6599	0.7231	0.7247	2
		1.0000	0.8510	0.7568	0.2562	0.9428	0.8799	0.8872	3
			1.0000	0.9184	0.4666	0.9192	0.9277	0.8971	4
				1.0000	0.5102	0.8529	0.8395	0.8178	5
					1.0000	0.3605	0.4111	0.4054	6
						1.0000	0.9523	0.9485	7
							1.0000	0.9924	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	106.9	Na = -11.67 + 0.1188 SC	183.3
K	13.6	K = 6.28 + 0.0074 SC	7.0
Ca	80.4	Ca = 29.28 + 0.0512 SC	102.1
Mg	14.5	Mg = - 0.78 + 0.0153 SC	8.2
Cl	165.4	Cl = -35.51 + 0.2012 SC	2891.0
HCO_3	136.0	HCO_3 = 114.6 + 0.0215 SC	339.3
SO_4	113.2	SO_4 = - 5.95 + 0.1193 SC	229.1
TDS	673.2	TDS = 29.42 + 0.6446 SC	925.8
SC	998.8		

Regression Against Discharge

KSGS-KSHD Summer 1966

Discharge Range 110 - 2,500 cfs

Regression Equation	Correlation Coefficient
$Cl = 10^{(2.345 - 0.0004006Q)}$	-0.8415
$SO_4 = 10^{(2.357 - 0.0008761Q)}$	-0.9568
$TDS = 10^{(2.357 - 0.0002543Q)}$	-0.8900
$SC = 10^{(3.101 - 0.0002668Q)}$	-0.8764

Only one of the twelve observations used in developing these regression equations had an observed discharge greater than 700 cubic feet per second.

Station 15 Saline River above New Cambria

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	0.6158	0.7831	0.8941	0.9607	0.6985	0.9620	0.9585	0.8329	1
	1.0000	0.7034	0.6471	0.7431	0.3938	0.7596	0.7630	0.8678	2
		1.0000	0.9251	0.8174	0.9154	0.8434	0.8608	0.7957	3
			1.0000	0.9188	0.8412	0.9251	0.9421	0.8401	4
				1.0000	0.6608	0.9904	0.9938	0.9166	5
					1.0000	0.6826	0.7109	0.5977	6
						1.0000	0.9931	0.9208	7
							1.0000	0.9347	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	249.7	Na = 0.71 + 0.1468 SC	6213.0
K	17.5	K = 8.88 + 0.0051 SC	5.5
Ca	87.2	Ca = 38.18 + 0.0289 SC	316.0
Mg	20.1	Mg = 1.12 + 0.0112 SC	34.0
Cl	355.1	Cl = -18.84 + 0.2204 SC	6037.0
HCO_3	167.9	HCO_3= 110.5 + 0.0338 SC	1345.0
SO_4	166.9	SO_4= 1.28 + 0.0976 SC	1117.0
TDS	1087.0	TDS = 110.9 + 0.5756 SC	32×10^3
SC	1697.0		

Station 16 Solomon River at Niles

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.7030	0.8486	0.9330	0.9190	0.7607	0.8947	0.9302	0.9210	1
	1.0000	0.7707	0.7161	0.6934	0.5837	0.7262	0.7105	0.7350	2
		1.0000	0.9133	0.8257	0.8727	0.9591	0.8642	0.9001	3
			1.0000	0.9724	0.9270	0.9504	0.9807	0.9854	4
				1.0000	0.8685	0.9117	0.9920	0.9830	5
					1.0000	0.8797	0.8778	0.9120	6
						1.0000	0.9390	0.9604	7
							1.0000	0.9890	8
								1.0000	9

Solomon River at Niles 6-8769

USGS-KSHD October 1958 - September 1964 65 Observations

1.0000	0.6760	0.7970	0.9914	0.7934	0.8207	0.9480	0.9775	1
	1.0000	0.6686	0.6439	0.9328	0.8619	0.8515	0.8003	3
		1.0000	0.7592	0.7767	0.8703	0.8693	0.8431	4
			1.0000	0.7586	0.7743	0.9277	0.9668	5
				1.0000	0.8312	0.9075	0.8761	6
					1.0000	0.9290	0.8930	7
						1.0000	0.9891	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	125.5	Na = -16.90 + 0.1303 SC	1211.0
K	15.9	K = 9.19 + 0.0062 SC	12.9
Ca	73.4	Ca = 26.87 + 0.0425 SC	168.9
Mg	15.8	Mg = -1.52 + 0.0159 SC	3.0
Cl	175.3	Cl = -64.58 + 0.2194 SC	667.6
HCO_3	180.2	HCO_3= 82.20 + 0.0897 SC	648.2
SO_4	116.3	SO_4= -4.61 + 0.1106 SC	410.5
TDS	730.0	TDS = 56.03 + 0.6164 SC	3403.0
SC	1093.0		

USGS-KSHD October 1958 - September 1964

Na	116.2	Na = -37.48 + 0.1362 SC	203.5
Ca	94.0	Ca = 31.25 + 0.0556 SC	409.5
Mg	17.8	Mg = -0.05 + 0.0159 SC	24.1
Cl	137.0	Cl = -54.96 + 0.1702 SC	477.5
HCO_3	267.0	HCO_3= 97.67 + 0.1501 SC	1610.0
SO_4	147.7	SO_4= -0.23 + 0.1311 SC	1030.0
TDS	701.5	TDS = 27.90 + 0.5971 SC	1868.0
SC	1128.0		

Station 16 Solomon River at Niles

Regression Against Discharge

KSGS - KSHD

Summer 1966

Range of Discharge 30 - 4,800 cfs

Regression Equation	Correlation Coefficient
$Cl = -8.496 + 14.16/\log Q$	0.9556
$SO_4 = 10^{(2.079 - 0.0004353Q)}$	-0.9328
$TDS = -1381 + 783.7/\log Q$	0.7076
$SC = -321.33\ Q^{-0.002318}$	0.9231

Only one of the twelve discharges used in developing these regression equations had an observed discharge greater than 180 cubic feet per second.

Station 17 Salt Creek near Minneapolis

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
	2	3	4	5	6	7	8	9	
1.0000	0.6751	0.7047	0.9604	0.9586	0.6275	0.9384	0.9853	0.9830	1
	1.0000	0.5611	0.7912	0.7189	0.3418	0.8178	0.7558	0.7257	2
		1.0000	0.7368	0.6395	0.7903	0.7166	0.7261	0.7280	3
			1.0000	0.9238	0.5849	0.9792	0.9828	0.9828	4
				1.0000	0.6352	0.8990	0.9567	0.9604	5
					1.0000	0.4751	0.6319	0.6724	6
						1.0000	0.9618	0.9427	7
							1.0000	0.9912	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	477.5	Na = -66.88 + 0.1902 SC	4182.0
K	17.4	K = 11.77 + 0.0020 SC	11.4
Ca	79.8	Ca = 46.70 + 0.0116 SC	392.9
Mg	28.1	Mg = 0.40 + 0.0097 SC	10.9
Cl	671.4	Cl = -80.40 + 0.2627 SC	19×10^3
HCO_3	224.8	HCO_3 = 144.6 + 0.0281 SC	3152.0
SO4	210.9	SO_4 = - 9.23 + 0.0769 SC	2451.0
TDS	1707.0	TDS =9065.0 + 0.5647 SC	19×10^3
SC	2863.0		

Station 18 Solomon River below Glen Elder Dam

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 11 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.8573	0.5777	0.9598	0.9895	0.4852	0.9447	0.9775	0.9803	1
	1.0000	0.5468	0.8671	0.8757	0.5133	0.8693	0.8726	0.8922	2
		1.0000	0.6904	0.5483	0.4149	0.7559	0.6833	0.6640	3
			1.0000	0.9490	0.4040	0.9720	0.9793	0.9732	4
				1.0000	0.4843	0.9443	0.9805	0.9880	5
					1.0000	0.4601	0.4925	0.4934	6
						1.0000	0.9719	0.9776	7
							1.0000	0.9964	8
								1.0000	9

The sample for June 27, 1966 was omitted from the computations

Solomon River at Beloit 6-8760

USGS-KSHD October 1957 - September 1964 46 Observations

1.0000	0.1904	0.7157	0.9933	0.3578	0.6024	0.8375	0.9039	1
	1.0000	0.6116	0.1098	0.9285	0.8079	0.6888	0.5780	3
		1.0000	0.6631	0.6845	0.8963	0.8875	0.8877	4
			1.0000	0.2846	0.5306	0.7866	0.8643	5
				1.0000	0.7631	0.7573	0.6812	6
					1.0000	0.9115	0.8625	7
						1.0000	0.9857	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	113.6	Na = -65.11 + 0.1634 SC	714.4
K	18.9	K = 12.99 + 0.0054 SC	5.0
Ca	90.0	Ca = 65.22 + 0.0226 SC	426.6
Mg	18.5	Mg = 2.82 + 0.0143 SC	7.5
Cl	138.5	Cl = -103.40 + 0.2212 SC	784.9
HCO_3	204.4	HCO_3 = 169.70 + 0.0317 SC	2058.0
SO_4	155.5	SO_4 = 23.54 + 0.1207 SC	444.3
TDS	719.5	TDS = 59.79 + 0.6032 SC	1729.4
SC	1094.0		
USGS-KSHD	October 1957 - September 1964		
Na	81.4	Na = -69.23 + 0.1443 SC	530.4
Ca	114.1	Ca = 52.92 + 0.0586 SC	779.0
Mg	18.6	Mg = 3.07 + 0.0149 SC	6.8
Cl	90.4	Cl = -90.30 + 0.1731 SC	1152.0
HCO_3	277.3	HCO_3 = 129.30 + 0.1418 SC	2639.0
SO_4	181.8	SO_4 = 18.66 + 0.1563 SC	956.0
TDS	677.7	TDS = 18.59 + 0.6315 SC	1325.0
SC	1044.0		

Station 18 Solomon River Below Glen Elder Dam

Regression Against Discharge

KSGS-KSHD Summer 1966

Discharge Range 0.2 - 220 cfs

Regression Equation	Correlation Coefficient
$Cl = 179.0 + 35.82/\log Q$	0.7529
$SO_4 = 10^{(2.202 - 0.003452Q)}$	-0.7507
$TDS = 797.4 + 873.4/\log Q$	0.7334
$SC = 1228 + 1122/\log Q$	0.7482

Only one of the twelve observations used in developing these regression equations had an observed discharge greater than 50.0 cfs.

Station 19 Saline River at Tescott

Linear Correlation Coefficients

KSGS-KSHD — Summer 1966 — 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.8945	0.7674	0.9523	0.9797	0.4629	0.9805	0.9795	0.9176	1
	1.0000	0.6986	0.9451	0.8893	0.4468	0.8931	0.9523	0.9324	2
		1.0000	0.7695	0.8009	0.8268	0.8349	0.7772	0.7120	3
			1.0000	0.9505	0.5832	0.9390	0.9742	0.9243	4
				1.0000	0.5330	0.9833	0.9800	0.9197	5
					1.0000	0.5435	0.4922	0.4144	6
						1.0000	0.9733	0.9037	7
							1.0000	0.9669	8
								1.0000	9

Saline River at Tescott 6-8695

USGS-KSGD — December 1949 - September 1964 — 99 Observations

1.0000	0.6817	0.9364	0.9991	0.6022	0.9059	0.9816	0.9837	1
	1.0000	0.8179	0.6847	0.9127	0.8834	0.8052	0.7898	3
		1.0000	0.9348	0.7319	0.9721	0.9700	0.9673	4
			1.0000	0.6004	0.9059	0.9823	0.9841	5
				1.0000	0.7400	0.7104	0.6942	6
					1.0000	0.9628	0.9589	7
						1.0000	0.9974	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD — Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	355.9	Na = -11.90 + 0.1643 SC	7803.0
K	20.0	K = 8.07 + 0.0053 SC	6.6
Ca	86.8	Ca = 52.89 + 0.0151 SC	343.2
Mg	25.0	Mg = 3.38 + 0.0097 SC	24.6
Cl	525.7	Cl = 23.57 + 0.2243 SC	14×10^3
HCO_3	157.7	HCO_3 = 139.20 + 0.0083 SC	509.1
SO_4	237.5	SO_4 = 27.89 + 0.0936 SC	3034.0
TDS	1450.0	TDS = 134.60 + 0.5875 SC	37×10^3
SC	2238.0		

USGS-KSHD — December 1949 - September 1964

Na	256.6	Na = -64.53 + 0.1702 SC	1513.0
Ca	111.4	Ca = 55.34 + 0.0297 SC	832.5
Mg	24.9	Mg = 0.39 + 0.0130 SC	18.2
Cl	358.8	Cl = -0.9916 + 0.2428 SC	3001.0
HCO_3	241.9	HCO_3 = 164.10 + 0.0412 SC	2852.0
SO_4	236.3	SO_4 = 9.73 + 0.1201 SC	1972.0
TDS	1159.0	TDS = 34.62 + 0.5959 SC	2884.0
SC	1186.0		

Station 19 Saline River at Tescott

Regression Against Discharge

KSGS-KSHD Summer 1966

Discharge Range 5 - 125 cfs

Regression Equation	Correlation Coefficient
Cl = 0163.1 + 114.3/log Q	0.9044
$SO_4 = 1245Q^{-0.7399}$	-0.8896
TDS = -1015 + 542/log Q	0.8604
SC = 01534 + 817/log Q	0.8389

Eleven of the twelve observations used in developing these regression equations had observed discharges between 5 and 30 cubic feet per second.

Station 20 Saline River at Sylvan Grove

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na	K	Ca	Mg	Cl	HCO_3	SO_4	TDS	SC	
1	2	3	4	5	6	7	8	9	
1.0000	0.5601	0.8079	0.9407	0.9837	0.0166	0.9522	0.9803	0.7940	1
	1.0000	0.7266	0.6682	0.5824	-0.4991	0.7339	0.6669	0.8253	2
		1.0000	0.8577	0.8036	-0.1893	0.8997	0.8654	0.8580	3
			1.0000	0.9732	-0.0401	0.9549	0.9700	0.8403	4
				1.0000	-0.0190	0.9618	0.9875	0.8240	5
					1.0000	-0.1553	-0.0789	-0.3109	6
						1.0000	0.9908	0.9183	7
							1.0000	0.8830	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	467.5	Na = -78.05 + 0.2014 SC	23×10^3
K	22.0	K = 10.92 + 0.0041 SC	7.6
Ca	99.3	Ca = 44.82 + 0.0201 SC	141.7
Mg	31.9	Mg = - 2.32 + 0.0126 SC	65.1
Cl	693.2	Cl = -90.88 + 0.2895 SC	39×10^3
HCO_3	162.5	HCO_3= 195.0 - 0.0120 SC	1316.0
SO_4	278.3	SO_4= 2.50 + 0.1018 SC	1886.0
TDS	1789.0	TDS = 22.29 + 0.6523 SC	12×10^4
SC	2708.0		

Station 21 Smoky Hill River near Mentor

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.3110	0.6236	0.3622	0.6913	-0.2996	0.6430	0.5858	0.4554	1
	1.0000	0.5089	0.6047	0.2912	0.2074	0.5316	0.6069	0.5970	2
		1.0000	0.8599	0.8284	0.2339	0.9458	0.9246	0.8362	3
			1.0000	0.5996	0.5874	0.7913	0.8072	0.6718	4
				1.0000	0.1676	0.9058	0.8889	0.8390	5
					1.0000	0.2721	0.2622	0.2038	6
						1.0000	0.9409	0.8799	7
							1.0000	0.9205	8
								1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	72.1	Na = 26.78 + 0.0549 SC	201.6
K	13.1	K = 3.794 + 0.0113 SC	4.0
Ca	84.5	Ca = 6.09 + 0.0950 SC	67.9
Mg	13.4	Mg = - 4.29 + 0.0215 SC	9.8
Cl	117.2	Cl = 4.60 + 0.1364 SC	136.9
HCO_3	138.5	HCO_3= 116.3 + 0.0269 SC	292.4
SO_4	106.4	SO_4= -35.01 + 0.1713 SC	149.6
TDS	559.7	TDS = 70.69 + 0.5925 SC	1106.0
SC	825.3		

Regression Against Discharge

KSGS-KSHD Summer 1966

Discharge Range 25 - 780 cfs

All regressions against discharge at this station have a correlation coefficient of less than 0.6500.

Station 22 Smoky Hill River near Langley

Linear Correlation Coefficients

KSGS-KSHD Summer 1966 12 Observations

Na 1	K 2	Ca 3	Mg 4	Cl 5	HCO_3 6	SO_4 7	TDS 8	SC 9	
1.0000	0.2192	0.5345	0.3368	0.5598	0.1097	0.4753	0.4810	-0.1252	1
	1.0000	0.1502	0.4943	0.2149	-0.1807	0.3465	0.3376	0.4327	2
		1.0000	0.7737	0.8463	0.5618	0.9014	0.8954	0.5692	3
			1.0000	0.7488	0.4965	0.8878	0.8249	0.7123	4
				1.0000	0.7421	0.8627	0.9362	0.5312	5
					1.0000	0.5129	0.6951	0.3087	6
						1.0000	0.9346	0.7127	7
							1.0000	0.6450	8
								1.0000	9

Smoky Hill River near Langley 6-8635

USGS-KSHD October 1961 - September 1964 37 Observations

1.0000	0.4828	0.5349	0.9885	0.1087	0.7253	0.9404	0.9412	1
	1.0000	0.2521	0.4975	0.7875	0.7464	0.7038	0.6843	3
		1.0000	0.5639	0.0804	0.6691	0.6162	0.5755	4
			1.0000	0.0921	0.7412	0.9516	0.9450	5
				1.0000	0.3606	0.3204	0.2903	6
					1.0000	0.8793	0.8624	7
						1.0000	0.9759	8
							1.0000	9

Regression Against Specific Conductance

KSGS-KSHD Summer 1966

Parameter	Mean of Observations	Regression Equation	Standard Deviation Squared
Na	73.6	Na = 92.14 - 0.0227 SC	218.7
K	12.7	K = 3.08 + 0.0118 SC	4.1
Ca	84.3	Ca = 22.20 + 0.0758 SC	81.2
Mg	13.2	Mg = -14.20 + 0.0334 SC	7.4
Cl	123.3	Cl = 44.52 + 0.0962 SC	159.5
HCO_3	116.0	HCO_3 = 61.92 + 0.0660 SC	280.2
SO_4	103.7	SO_4 = -15.11 + 0.1450 SC	138.0
TDS	576.3	TDS = 86.66 + 0.5975 SC	3396.0
SC	819.6		

USGS-KSHD October 1961 - September 1964

Na	135.4	Na = -48.02 + 0.1393 SC	95.2
Ca	100.6	Ca = 40.07 + 0.0460 SC	91.5
Mg	18.2	Mg = 3.91 + 0.0109 SC	9.1
Cl	230.0	Cl = -80.87 + 0.2361 SC	254.2
HCO_3	179.6	HCO_3 = 134.1 + 0.0346 SC	494.3
SO_4	154.3	SO_4 = 17.63 + 0.1038 SC	141.3
TDS	774.9	TDS = 6.15 + 0.5839 SC	648.8
SC	1316.0		

Station 22 Smoky Hill River near Langley

Regression Against Discharge

KSGS-KSHD Summer 1966

Discharge Range 50 - 850 cfs

Regression Equation	Correlation Coefficient

All regressions of chloride, sulfate, and total dissolved solids against discharge at this station have a correlation coefficient of less than 0.6500.

SC = 748.6 + 9577/Q	0.7522

The mathematical analyses may be effectively discussed under two broad sections. The first grouping includes the linear correlation coefficients and the regression equations between the individual parameters and specific conductance. The second considers the regression equations between the individual parameters and the discharge.

In the first section, a correlation coefficient of 0.85 has been arbitrarily chosen as the dividing line between an acceptable and an unacceptable relationship. This criterion has been applied to the data collected under this contract and to the data available from the program conducted jointly by the United States Geological Survey and the Kansas State Department of Health. This latter material will hereafter be referred to as the historical data. The observations available from the Kansas River, the Smoky Hill River, the Saline River and the Solomon River have been individually grouped. The other streams for which information was available from only one location have been considered individually.

No satisfactory correlations were observed at any of the seven stations on the Kansas River between potassium and any of the other parameters considered. Only two stations, Wamego and Lecompton, showed a satisfactory correlation between bicarbonate and specific conductance for the historical data. Only Lawrence exhibited a similar correlation during the summer of 1966.

All three of the historical stations on the Kansas River showed satisfactory correlation between bicarbonate and calcium and between bicarbonate and magnesium. This was not the case for the majority of the stations included in the 1966 survey. Some of the deviations between the historical and the 1966 data may be attributable to the unusually high proportion of water from Tuttle Creek Reservoir in the river during the latter period of the summer survey.

With these exceptions however, the relationships within the historical data support the short-term summer correlations. The data also strongly suggest that all of the parameters except bicarbonate and potassium could be calculated with a reasonable degree of accuracy from specific conductivity measurements.

Five stations were sampled on the Smoky Hill River. None of these sites exhibited a satisfactory correlation between bicarbonate and specific conductance. Only Enterprise showed a satisfactory correlation between potassium and specific conductance. A satisfactory correlation between potassium and chloride was also obtained at Enterprise. This is probably a reflection of the water from the Saline River although the New Cambria station does not share this correlation.

Only New Cambria and Enterprise have satisfactory correlations between specific conductance and calcium in the 1966 survey. The historical data from Enterprise does not

indicate as strong a relationship as the summer measurements but the regression equations between calcium and specific conductance are quite similar.

There appear to be a number of significant differences between the 1966 measurements and the historical data at Langley. This is surprising in that Kanapolis Reservoir is a relatively old impoundment and would be expected to be relatively stable from a water quality standpoint. No explanation for the deviations between the two sets of data is available at the present time.

The three stations on the Saline River exhibit relatively uniform water quality profiles. However, the relative concentration of each of the parameters monitored decreases downstream from the station at Sylvan Grove. The summer data at Tescott reflects the lower than average flows experienced during the period.

The complete lack of correlation between bicarbonate and all other parameters at Sylvan Grove may indicate water quality changes taking place in Wilson Reservoir which began storage in June 1965.

The two stations on the Solomon River compare favorably with each other for both the 1966 and the historical data. A significant gain in total dissolved solid load appears to occur between the stations.

Both the Saline River and the Solomon River are high in sodium chloride and calcium bicarbonate.

The dominant chemical contribution to Salt Creek which lies between the Solomon and the Saline Rivers appears to be from sodium chloride and magnesium sulfate.

The Wakarusa River and the Delaware River are remarkably similar although the Wakarusa appears to have more uniform characteristics. Both rivers are rich in calcium and have a high correlation between bicarbonate and specific conductance.

The data taken during 1966 on the Republican River below Milford Reservoir does not appear to correlate as well as the historical data obtained at the town of Milford before storage began. Additional data will be required to clearly delineate this trend.

The 1966 data and the historical data for the Big Blue River below Tuttle Creek Dam appear to be quite different. No satisfactory correlations for any of the summer data was obtained. The historical data exhibits a number of satisfactory correlations.

Storage in Tuttle Creek Reservoir began in March 1962. The bulk of the historical data was therefore obtained either before or immediately after the start of storage. The differences between the historical data and the short-term summer data suggest that changes in the water chemistry are occurring within the impoundment at the present time.

As pointed out by Durum (5), the linear regression equations between specific conductance and the individual dissolved ions break down at high flows. This can be overcome by using

a second degree parabola or a cubic parabola without a constant term as suggested by Ledbetter and Gloyna (6). These possibilities should be investigated.

All regression equations having a correlation coefficient greater than 0.65 were included in the section relating the individual quality parameters to discharge. Although the applicability of a number of the equations presented is limited by the short range in flow experienced during 1966, it is of interest to note that the parabolic equation

$$C = aQ^b$$

where C = mineral concentration

Q = discharge

a & b = regression constants

suggested by Ward (7) and modified by Ledbetter and Gloyna (6) is applicable in only a limited number of cases. This phenomenon has also been apparent in the graphical analyses of the historical data which have been conducted in the development of the inorganic aspects of the mathematical model. Additional research should be conducted to determine a mathematical equation which will successfully characterize the relationships between discharge and dissolve ion concentration for this geographical region.

(1) The concentration of most of the chemical parameters tested can be calculated with a reasonable degree of accuracy from specific conductivity measurements. The chief exceptions to this rule are bicarbonate and potassium.

(2) The linear relationships derived between specific conductance and the individual dissolved ions are satisfactory for most applications. Curvalinear equations should provide relationships applicable over an increased discharge range. This possibility should be investigated.

(3) The short term 1966 observations compare quite favorably with the historical data at all stations except the Smoky Hill River near Langley, the Saline River at Sylvan Grove, the Big Blue River below Tutlle Creek Reservoir, and to a lesser extent, the Republican River at Milford. All of these anomalies are located directly below reservoirs and may indicate changes in the water chemistry caused by the impoundments. Additional investigations in this area would appear to be warrented.

(4) The equations between dissolved ion concentration and discharge suggested by this investigation do not conform to the relationships found applicable in other geographical regions. Additional research should be conducted to determine a mathematical equation which will successfully characterize these relationships for this geographical region.

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